Strategic Plan for Lake Erie Partners: Sustaining Healthy Waters for Lake Erie's Economy

Healthy Lake – Healthy Economy

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Dear Lake Erie Stakeholders:

Lake Erie's massive algal bloom in 2011 covered 1,600 miles of the western and central basins, was over two feet thick in places, and resulted in 2.5 times the volume of algae of the preceding largest volume recorded in the lake. This bloom had a detrimental effect on lake-dependent businesses and property values, added significant costs to water treatment plant operators, and negatively impacted fish and wildlife. It was clearly a wakeup call for government, researchers, businesses, environmental organizations, and citizens to join forces to reduce nutrient levels in Lake Erie.

We formed an economic interest group for Lake Erie - the Lake Erie Improvement Association (LEIA) - in 2011 in response to that bloom with the goal to reduce nutrient loading and help address other Lake Erie challenges. LEIA's mission is a Lake Erie watershed-wide economic sustainability initiative dedicated to healthy waters and fish by promoting cooperation and wise resource management for the benefit of the Lake Erie basin. LEIA members are stewards of Lake Erie, the shallowest, most biologically productive, and most fragile of the Great Lakes. We are advocates for Lake Erie, which is a source of drinking water for more than 11 million people and is used for manufacturing, shipping, fishing, and recreation. In the seven coastal counties in Ohio alone, Lake Erie helps support an $11.5 billion tourism industry. LEIA members are comprised from the boating, fishing, and tourism industries; waterfront property owners; and other economically impacted parties that rely on a healthy Lake Erie.

Though the 2012 drought conditions helped provide a brief respite from large harmful algal blooms in the lake, we know that we will see the massive blooms again if we do not change policies and practices throughout the watershed. Lake Erie made a comeback in the 1970s. I am confident that Lake Erie stakeholders can once again successfully work together to realize improved water quality conditions that, among the many benefits, will foster a strong and sustainable Lake Erie-based economy that is really unique among the Great Lakes and that contributes immeasurably to the quality of life for millions of individuals who live, work and recreate in its basin.

We are so pleased to present LEIA's Strategic Plan that specifies direct actions to protect and restore Lake Erie. We recommend continuous lake and tributary monitoring that will produce data that can serve as the foundation for the development of science-based solutions. We recommend that public funds be targeted to efforts that have the highest effectiveness for nutrient reduction, and policy and program changes, modified practices, and implementation of new technologies. This Strategic Plan identifies actions for LEIA to better serve as a lake advocate and encourages others to take actions to restore and protect Lake Erie.

While our plan is primarily focused on nutrient overloads and the resulting harmful algal blooms, Lake Erie faces many other threats, including invasive species, sediments and turbidity, bacteria, water supply and use, habitat loss, changing weather and climate, and declining sport fish populations. All of these issues are connected and must be addressed through thoughtful assessment and wise management to restore and protect the ecological, environmental and economic value of Lake Erie.

Our thanks go out to the many individuals and agencies currently working for our Great Lake. I extend my gratitude to the individuals representing marinas, charter boat captains, environmental organizations, the agricultural community, private organizations, and public agencies that dedicated significant time to preparing and reviewing this plan. Thank you in advance for your continued dedication to our lake by helping to implement these critically important recommendations.

Yours for Lake Erie,

Jim Stouffer, Jr.

James V. Stouffer, Jr.
President, Lake Erie Improvement Association
Chairman & CEO, Catawba Island Club

Strategic Plan for Lake Erie Partners:
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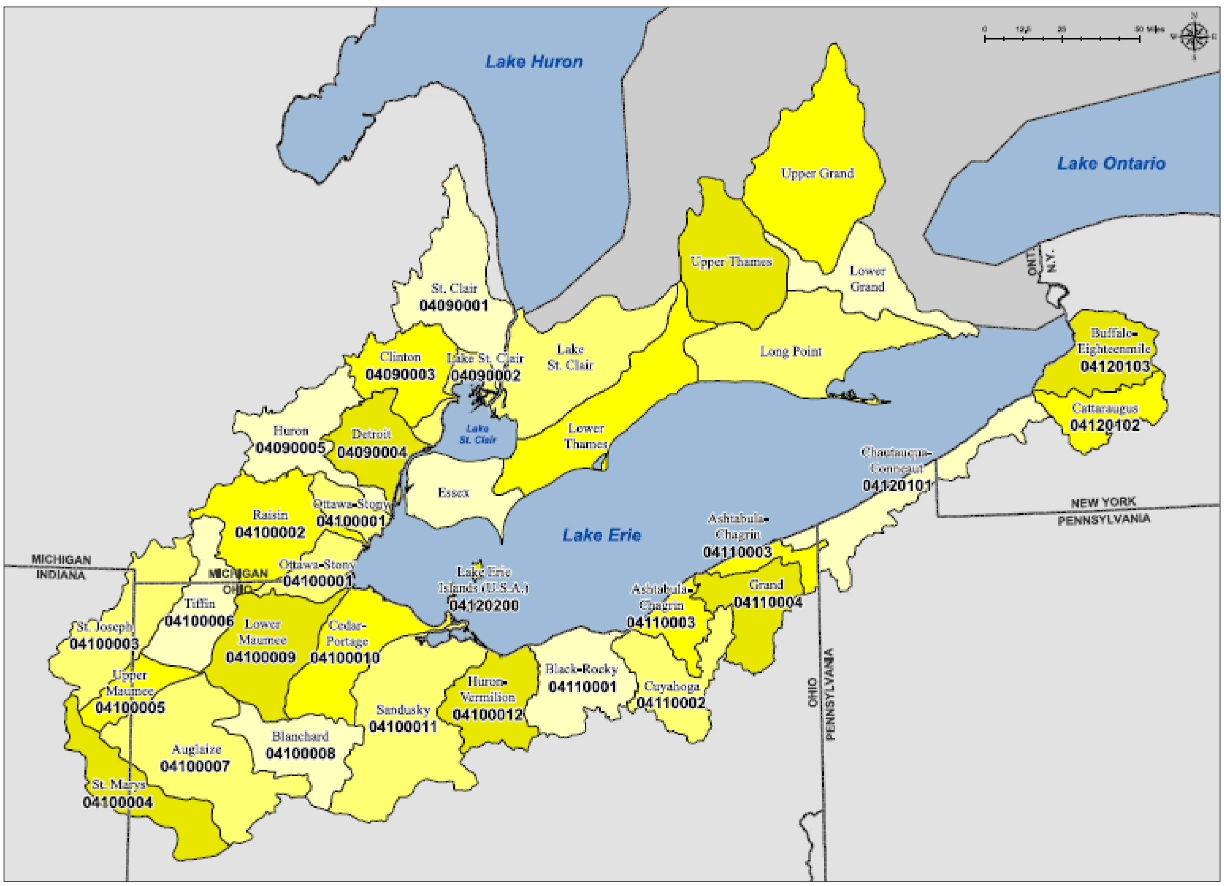
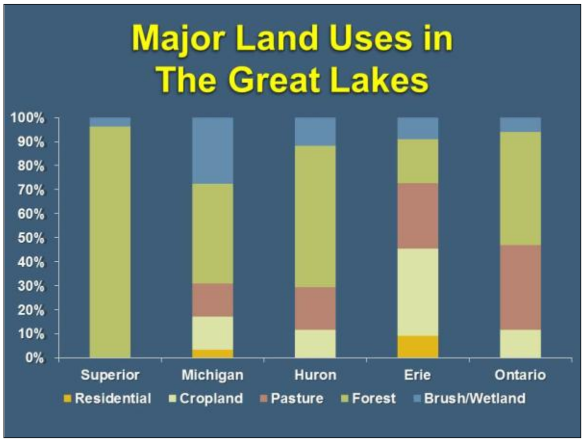
1.1 Introduction to Lake Erie

Lake Erie is the shallowest, warmest, and most biologically productive of the Great Lakes. About one-third of the total population of the Great Lakes basin resides within the Lake Erie watershed. Approximately 12 million people live in the watershed, with 17 metropolitan areas having more than 50,000 residents. The lake provides drinking water for about 11 million of these inhabitants (U.S. Environmental Protection Agency [EPA], 2012). Lake Erie is the eleventh largest lake in the world (by surface area), the fourth largest of the Great Lakes in surface area and the smallest by volume. It has 856 miles of shoreline, 9,000 square miles of surface area, is 241 miles long, and is 57 miles across at its widest point. Its average depth is 62 feet with a maximum depth of 210 feet (Ohio Department of Natural Resources [ODNR], 2012).



Sub-watershed delineation (8-digit Hydrologic Unit Codes) for the Lake Erie watershed. Source: ODNR, 2012

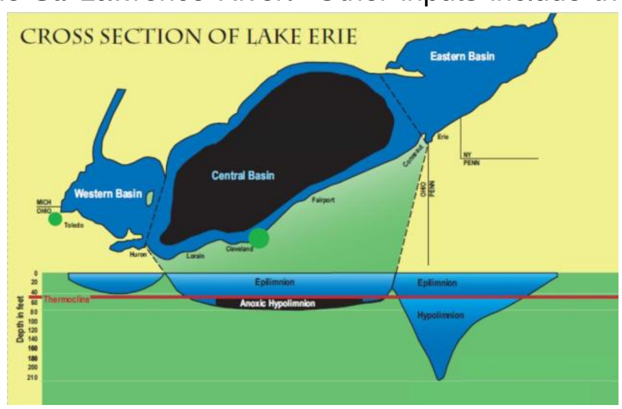


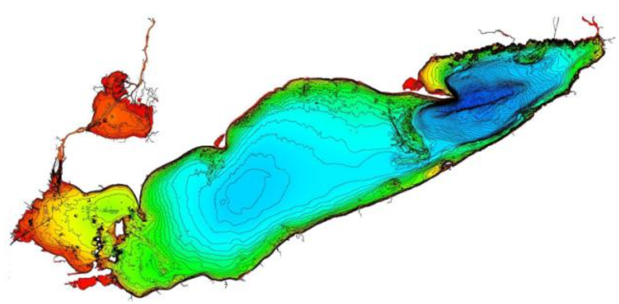
Major land use in the Great Lakes (Source: Reutter, 2012).

Lake Erie is bordered on the north by the Canadian province of Ontario, on the south by the states of Ohio, Pennsylvania, and New York, and on the west by the state of Michigan. Indiana is also a part of the greater Lake Erie watershed via the Maumee River, an important lake tributary. Major cities along the lake include Monroe, Michigan; Toledo, Sandusky, and Cleveland, Ohio; Erie, Pennsylvania; Buffalo, New York; and Port Stanley, Ontario.[1] The Lake Erie watershed encompasses 22,720 square miles (ODNR, 2012). Lake Erie has 18 islands in the United States (U.S.) and 13 islands in Canada. The western Lake Erie islands archipelago is the largest collection of islands in Lake Erie. Lake Erie has 31 lighthouses (Friends of Lighthouses, 2008).

Ninety percent of Lake Erie's water comes from the upper Great Lakes (Lakes Superior, Michigan and Huron, as well as the St. Clair River, Lake St. Clair and numerous tributaries) via the Detroit River (U.S. EPA, 2007). The eastern outlet is Lake Ontario through Niagara Falls. It eventually drains into the Atlantic Ocean via the St. Lawrence River. Other inputs include the Maumee (estimated at 3% of Lake Erie's water volume), Portage, Cuyahoga and Grand Rivers. The rest comes from precipitation. Lake Erie has a retention time of 2.6 years, the shortest of the Great Lakes, with the western basin typically having a retention time of 20-50 days (U.S. EPA, 2012; Reutter, 2012).

The lake is naturally divided into three basins: west, central, and east. Like the rest of the Great Lakes, Lake Erie was formed by the movement of glaciers. The glaciers carved away more land in the central and eastern basins because the bedrock is made of shale, which is much softer than the dolomite and limestone of the western basin. The western basin is shallow, with an average depth of 24 feet and a maximum depth of 64 feet. The central basin is fairly uniform in depth, with an average depth of 60 feet and a maximum depth of 82 feet. The eastern basin is the deepest, with an average depth of 82 feet and a maximum depth of 210 feet.





Top: Lake Erie basins (Source: Ohio Sea Grant, 2009)
Bottom: Bathymetric map of Lake Erie
(Source: NOAA, 2012)

[1] For the purposes of this plan, the Lake Erie watershed does not include the Detroit River, St. Clair River, and Lake St. Clair. These waters are included in the Lake Erie watershed in the 2012 Great Lakes Water Quality Agreement.

The large differences in the basins cause them to behave quite differently. Stratification often occurs in the summer based on density differences in the water due to temperature variations. The shallow western basin rarely experiences thermal stratification, while the central and eastern basins stratify annually. The central zone is unique in that it has a thin layer of dense, cold water at the bottom in which some of the oxygen gets used up seasonally, resulting in what is termed the “dead zone.” Bottom-dwelling fish and other organisms that cannot leave this area often die as a result. This “dead zone” has been expanding over the last 15 years (Ohio Sea Grant, 2009). The eastern basin is much deeper, with the colder bottom water having sufficient oxygen. Turnover occurs in the spring and fall when those temperature differences minimize and the layers mix, helping to re-oxygenate the water and redistribute nutrients. Stratification affects the internal dynamics of the lake, resulting in the three basins behaving almost as three separate lakes.

With its shallow, warm waters, the western basin is the most biological productive basin of Lake Erie and supports a wide diversity of life from microscopic organisms to over 140 species of fish. The warm waters of the western Lake Erie basin provide spawning for walleye, yellow perch, bass, and other species. Generally, as the water in the western basin warms in the summer, many of the fish move eastward to the central and eastern basins for temperatures similar to those in the early spring in the western basin. Because of the shallowness, Lake Erie is especially vulnerable to fluctuating water levels.

1.2 Use of the Lake and Economic Benefits

Lake Erie supports hundreds of thousands of shipping, industry, energy, agriculture, commercial fishing, and tourism-related jobs.

Shipping

There are 15 ports on Lake Erie, each importing and exporting into and out of the Lake Erie watershed and connecting ports across the nation and world. Principal cargo handled at the ports varies, but includes coal, iron, ore, grain, petroleum, steel products, limestone, and sand (Great Lakes Group, 2010). The Port of Toledo alone handled $381.4 million in cargo with an additional $370.4 million in income and consumption in 2010 created by the Port (Martin Associates, 2011). The Lake Erie seaports combined generate approximately $1 billion in revenue each year (Kieser & Associates, 2008). These ports are so important that during the next 10 years, the U.S. and Canadian governments will commit close to $1 billion to improve infrastructure and modernize navigation systems to improve transportation performance, reliability and create jobs (Marine Delivers, 2012).

Industry

The Lake Erie shoreline has 16 coal and nuclear power plants, one wind power plant near Buffalo, as well as many other industrial sites that include oil refineries, auto plants and manufacturing (Energy Justice Network, 2012). These facilities typically use Lake Erie water in their manufacturing and/or cooling processes.

Agriculture

Much of the land in the Lake Erie basin is used for intensive row crop farming. In the Maumee watershed alone, the market value of corn, soybeans, wheat, hay, oats and livestock exceeds $1 billion per year (U.S. Department of Agriculture Natural Resources Conservation Service [NRCS], 2005). The basin is also well known for its specialty crops. The Ohio wine industry contributes another $582.8 million in sales, wages and taxes paid (MFK Research, 2010). In

2011, the Ontario wine industry contributed $269 million in sales and is expected to grow by 20% in the next five years (Wine Council of Ontario, 2012).

Commercial and Recreational Fishing

In general, Lake Erie has approximately 2% of the Great Lakes water, but has over 50% of the fish most in demand such as walleye, yellow perch and bass (Reutter, 2012). Sport fishing is a multi-billion dollar industry in the Great Lakes. Anglers in Lake Erie spent $518.9 million pursuing their sport in 2009. That level of recreational expenditures supports $1.2 billion in total sales, $632.7 million in personal income and 10,708 jobs. Walleye and yellow perch are the most popular target species. The walleye fishing industry alone is valued at tens of millions of dollars annually (U.S. EPA, 2009). In Lake Erie, commercial and recreational fishing generate $1.4 billion in total sales, $711.1 million in personal income and support 14,052 jobs (Gentner and Bur, 2009). The Lake Erie Committee of the Great Lakes Fishery Commission, composed of representatives from the Michigan, New York, Ohio, Ontario, and Pennsylvania agencies administering their respective fisheries, leads the effort in the management of sport fish in Lake Erie. This group also issues recommended catch limits for sport fish.

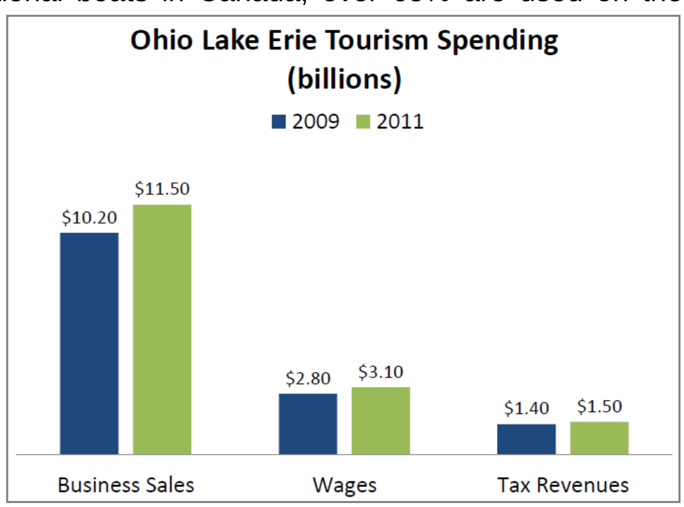
The majority of Lake Erie's commercial fish harvest comes from Canadian waters, with over 500 active licenses. The 2011 dockside value of mainly perch, walleye and smelt was $33 million Canadian Dollars (CND). When processing and sales to restaurants and grocery stores are included, commercial fishing in Canada contributed over $234 million (CND) in 2011 (Ontario Ministry of Resources, 2012). Within the U.S, the 2010 commercial catch of over 4.9 million pounds of fish was valued at over $4.6 million (USGS, 2012). Including only the U.S., Lake Erie commercial fishing contributed over 25% of the total commercial fishing harvest in the Great Lakes (U.S. Army Corps of Engineers [USACE], 2012).

Boating

There are over 2.2 million registered boats in Ohio, Michigan, Pennsylvania, and New York, with recreational boating generating economic impacts totaling $15.9 billion annually and over 100,000 jobs within these four states (Great Lakes Fishery Commission, 2007). There are over 600 marine dealers and over 750 Ohio licensed fishing guides that operate on Lake Erie (ODNR, 2012). Of the 1.2 million recreational boats in Canada, over 65% are used on the Great Lakes (Marbek, 2010). Total direct expenditures associated with recreational boating in Canada for 2006 was estimated at $14 billion, with direct and indirect impacts in Ontario estimated at $5.1 billion (Marbek, 2010).

Tourism

Lake Erie tourism is a massive industry. The shoreline attracts millions of visitors for boating, fishing, swimming, birding, ferry boat trips to the islands, amusement and water parks, natural areas, and historic site visits. In the seven Ohio counties that border Lake Erie, total visitor spending was $10.2 billion, total wages were $2.8 billion, total taxes were $1.4



Ohio Tourism Spending in 2009 and 2011 (Data Source: Tourism Economics, 2012)

billion, and total tourism employment was 114,703 in 2009. In 2010, total visitor spending was up 6%, to $10.9 billion. In 2011, there were $11.5 billion in business sales, $3.1 billion in wages, $1.5 billion in tax revenues, and over 117,513 jobs supported by the tourism industry. It was also estimated that tourism supports 1 in 10 salaried jobs in Ohio's Lake Erie region (Tourism Economics, 2012). The seven Ohio counties generate nearly a third of Ohio's total tourism dollars. While these statistics do not isolate lake-dependent activities, it is safe to presume that the lake is a destination point and that a large percentage of these dollars was generated because of this resource.

Economic Impact Evaluation

While much of the existing economic studies are dated or are not specific to Lake Erie, the International Joint Commission (IJC) is currently compiling data on the economic impact of the lake to the U.S. and Canadian economies through shipping, industry, energy, agriculture, commercial fishing, and tourism. This information will assist in communicating the value of Lake Erie.

1.3 Pollution History/Water Quality Changes

Lake Erie is the smallest in volume of the Great Lakes and is exposed to the greatest effects from urbanization and agriculture. The Maumee River watershed, the largest in the Great Lakes, is over 4 million acres. Termed the Great Black Swamp, this area had extensive wetlands prior to draining in the late 1800s. Because of the fertile soils, the Lake Erie basin is intensively farmed and is the most densely populated of the five Great Lakes basins. It also experiences the highest sedimentation of all of the Great Lakes. Urban sprawl has increased, which in turn increases habitat loss and degradation and nonpoint source pollution.

The highest pollution loads in the Lake Erie watershed came after the 1940s when 30 years of industrial growth had resulted in unregulated and often untreated discharges into the waterways. Urban sprawl caused stresses on the existing sanitation systems resulting in much of the waste being discharged into lakes and rivers. In the 1940s and 1950s, the Detroit River experienced massive duck kills due to oil pollution. In the late 1940s, it was determined that there was enough oil being discharged into the Detroit and Rouge rivers annually to pollute the entire western basin of Lake Erie. During this period, phosphates were still used in household as well as commercial detergents and fertilizers. In the 1960s, after the Detroit River was characterized as one of the most polluted rivers in the nation, the Federal Water Pollution Control Agency (predecessor to U.S. EPA) established the Large Lakes and Rivers Research Station on Grosse Ile to monitor environmental quality. In 1965, a *Time Magazine* article documenting massive algal blooms pronounced Lake Erie dead. In the 1970s, the fisheries of Lake St. Clair, St. Clair River, Detroit River, and western Lake Erie had to be closed due to mercury discharges. In 1972, the environmental problems of the Lake Erie watershed helped provide rationale for the passage of the Clean Water Act and the Canada-U.S. Great Lakes Water Quality Agreement (GLWQA).

By the mid-1980s, the amount of nutrients decreased to levels that reduced the large algal blooms and fish populations rebounded. Since the 1970s, there have been steady declines in many chemicals in the Great Lakes basins. But, because of the ability of several chemicals to bioaccumulate and persist in the environment, they remain a significant concern.

The lake is changing once again. Lake Erie's overall targeted phosphorus load of 11,000 metric tons (12,125 tons) has been met since the late 1980s and total phosphorus loads from Lake

Erie tributaries remained fairly constant. However, the dissolved reactive phosphorus (DRP) loads increased since the mid-1990s. This increase in DRP coincided with the reappearance of algae blooms. Additionally, invasive species being transported via ballast water drastically altered the ecological balance of the lake. One example is the establishment of the zebra (*Dreissena polymorpha*) and quagga (*Dreissena bugensis*) mussels, referred to collectively as dreissenids.

States assess the impairments of watersheds and establish pollutant load reduction targets through total maximum daily load (TMDL) assessments. In Ohio, the Ohio Environmental Protection Agency (Ohio EPA) TMDL reports indicate that impairments of all eight subwatersheds of the western basin still exist in the form of siltation, flow and habitat alteration, organic enrichment/low oxygen, metals, and turbidity issues. Similar impairments were identified in the other Lake Erie watersheds in Ohio as well as watersheds in Michigan, New York, and Pennsylvania (New York State Department of Environmental Conservation [NYDEC], 2010). While U.S. EPA has encouraged states to adopt numeric standards for causal (e.g. nitrogen and phosphorus) and response (e.g. chlorophyll a) parameters, few states include numeric standards for nutrients (U.S. EPA, 2008). To date, no Lake Erie-wide or even a western basin TMDL has been prepared. One result of the TMDL would be the establishment of numeric standards for nutrients in Lake Erie.

The 2008 update of the Lake Erie Lakewide Management Plan (LaMP) states that Lake Erie still has 11 of the 14 potential impairments to its beneficial use. These impairments include degradation of fish, wildlife and habitat, dredging/sediment issues, and recreation water quality impairments. The status of these beneficial use impairments is periodically updated as the Lake Erie LaMP is revised (LaMP, 2008). The 2011 annual report notes that issues such as hypoxia and harmful algal blooms remain a problem (Lake Erie LaMP, 2011). The Great Lakes Commission Phosphorus Reduction Task Force identified several findings regarding nutrient loading including an increased number of livestock in certain areas, an increase in the percentage of urban and suburban land use concurrent with increased fertilizer use and a lack of data on phosphorus loading for most major sub-basins of the Great Lakes basin (Great Lakes Commission, 2012).

While multiple concerns remain for Lake Erie, it is important to emphasize the positive aspects that Lake Erie has to offer. Many species are returning to areas previously uninhabited. Monitoring programs have documented that since the 1960s, there have been significant reductions in pollutants such as oil, mercury, and chloride, as well as remediation of contaminated sediment.

While significant progress has been made in addressing Lake Erie issues, the resurgence of extensive harmful algal blooms (HABs) and nutrient issues and the threat of the establishment of Asian carp require immediate action to restore and protect the lake.

1.4 Water Quality and Economic Impacts

Lake Erie faces many water quality impacts, some of which were thought to have been addressed many years ago and others that are entirely new challenges. The following section breaks down the major water quality impacts and their potential sources. This list is not meant to be comprehensive. Impacts discussed below are the basis for the majority of the strategic actions outlined in this plan. It is expected that this list may need to be amended as conditions change.

A Primer on Phosphorus

Phosphorus enters Lake Erie in two basic forms: dissolved P and particulate P. Dissolved P can be present in organic (associated with carbon) or inorganic (not associated with carbon) forms. Within dissolved inorganic phosphorus is dissolved reactive phosphorus (DRP), which is largely bioavailable to algae and preferred over dissolved organic phosphorus. Particulate phosphorus is largely unavailable to algae.

Total Phosphorus (TP) includes the total dissolved and particulate phosphorus in a system. Due to the relative ease to measure, total phosphorus is frequently used to measure a lake's nutrient status and is also incorporated into many NPDES permits.

For a more detailed discussion on the forms of phosphorus and the phosphorus cycle, refer to the Ohio Lake Erie Phosphorus Task Force Final Report (2010). To view information about algae blooms, visit Ohio EPA's Algae 101 at www.ohioalgaeinfo.com.

1.4.1 Nutrient/Phosphorus Loading

Nutrients such as phosphorus and nitrogen are essential to the survival of lake ecosystems. However, excess nutrients can lead to eutrophication, or the over-enrichment of water, resulting in problems such as algae blooms, taste and odor issues, low oxygen levels, fish kills, and low transparency. Lake Erie experiences a significant amount of nutrient runoff compared to other Great Lakes due in part to the high percentage of agricultural and developed land. The amount of nutrients released from the lake bottom sediments over a specific time period – referred to as internal load - are unknown at this time. Phosphorus is considered to be the limiting nutrient in Lake Erie, except for a month or so in late summer when nitrogen must be reduced to limit algae.

Nutrient loading, or the total amount of nutrients entering the lake during a given time, is a result of both internal inputs (such as changes in the lake ecosystem) as well as external drivers (such as changes in the watershed). Nutrient sources are commonly divided into point (generally from pipes that requires a Clean Water permit) and nonpoint sources (from the land that does not require a Clean Water permit). The main nonpoint sources are agricultural runoff, stormwater runoff, and failing home sewage treatment systems. Agricultural contributions result from various forms of farm runoff, including manure, biosolids and commercial fertilizers. Within the Lake Erie Basin, an estimated 66% of the fertilizer handled in the basin is commercial, while manure and biosolids make up 27% and 7%, respectively (Ohio EPA, 2010). Point sources include wastewater treatment plant (WWTPs) discharges, combined sewer overflows (CSOs), and industrial effluents. Atmospheric inputs also contribute minimally to phosphorus input.

The Detroit WWTP, located on the southwest corner of the Detroit River near the mouth of the river, is the largest single-unit wastewater plant in the U.S. It serves 76 communities and four million people (Detroit Water and Sewerage Department, 2012). In the 1970s, it was the single largest contributor of phosphorus to Lake Erie (U.S. EPA, 2009). While the Detroit WWTP has greatly reduced its phosphorus load, it reported to U.S. EPA that the outfalls and CSOs discharged 552 metric tons (608 tons) of total phosphorus (TP) in 2010-2011. With the Great Lakes Water Quality Agreement targeted TP load for Lake Erie at 11,000 metric tons (12,125 tons), the Detroit WWTP contributes 5% of the Lake Erie TP load and is still a significant point source contributor of phosphorus to Lake Erie.

Tile drainage systems associated with agricultural land have had a pronounced impact on the Lake Erie watershed, which is one of the heaviest tile drained areas in the United States (Ohio EPA, 2010). Water and associated nutrients are transported rapidly through these systems. For example, a study in the Big Creek watershed in central Ohio showed that tile drainage accounts for 46% of the water discharge accounting for 41% of dissolved reactive phosphorus, and 34% of total phosphorus measured at the watershed outlet (King, 2012). It is unknown how much of this would have run off via overland flow if the drainage tile did not exist.

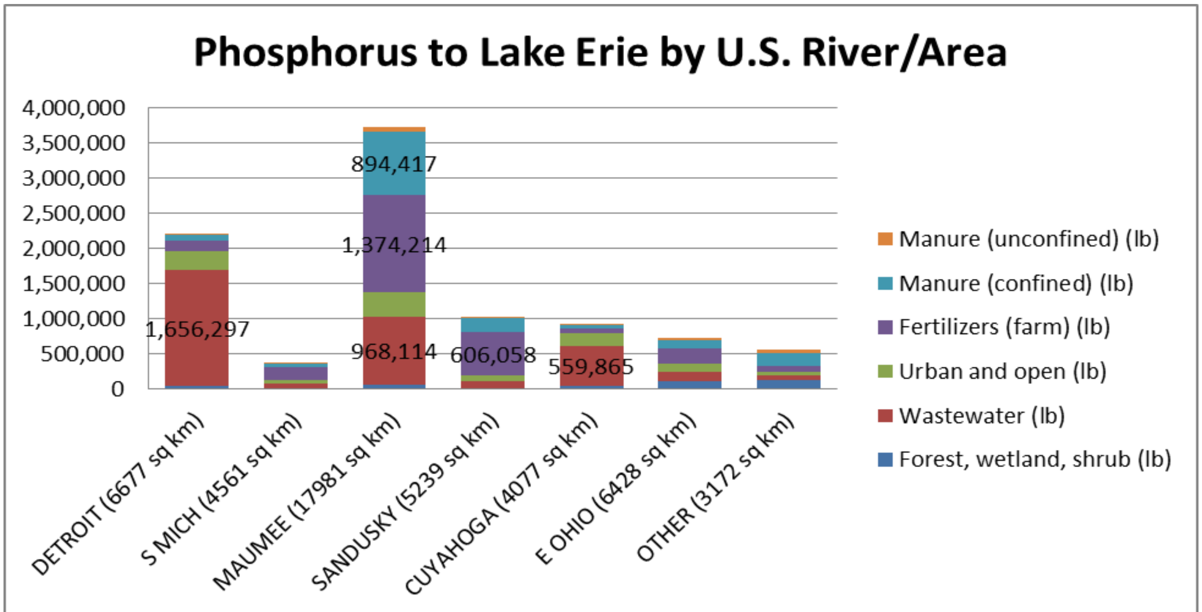
In the past, reductions in TP and DRP came from reducing point source and some nonpoint source loading. The major point source loading came from WWTPs. The United States and Canada completed major projects in the 1970s to upgrade WWTPs, which significantly reduced the point source contribution of phosphorus. By the late 1970s and 1980s, the Detroit WWTP reduced its phosphorus contribution to Lake Erie by over 90% (U.S. EPA, 2009). Many WWTP infrastructure and combined sewer and sanitary sewer system improvements continue to be completed throughout the basin with the help of federal and state funding programs, such as the State Revolving Fund program that is augmented by increased user fees. Additional reductions were achieved through the banning of phosphates in laundry detergents. While TP loads have increased minimally since 1995, DRP loads have increased steadily since the mid-1990s. Bioavailable phosphorus loading to Lake Erie from the Maumee and Sandusky rivers in 2011 was at the highest level since monitoring began 35 years ago (Ohio Sea Grant, 2011).

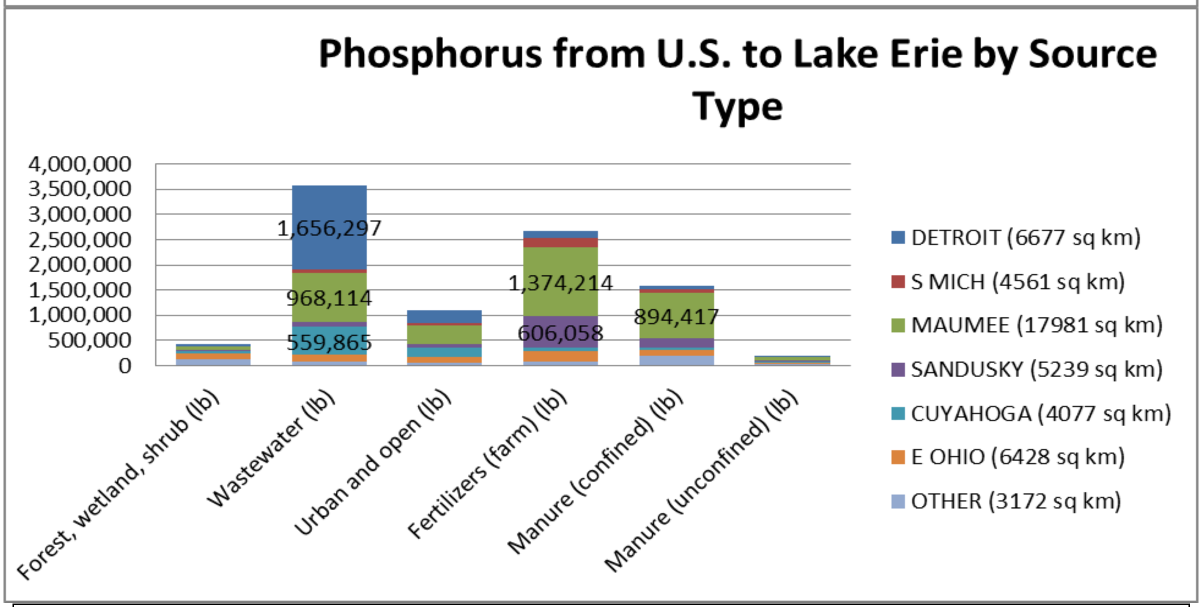
Nutrient loading to Lake Erie is highly dynamic, with the various Lake Erie tributaries (e.g. Maumee, Cuyahoga) and input types (e.g. nonpoint, point) contributing varying percentages of the annual phosphorus load. The lack of continuous monitoring throughout the Lake Erie Basin makes it hard to determine the contribution of these factors to the total phosphorus loads. Often, predictive models or measurements taken from Lake Erie tributaries are used to calculate the amount of phosphorus entering Lake Erie. The USGS SPARROW model (Spatially Referenced Regressions On Watershed attributes) empirically estimates the origin and fate of contaminants in streams and receiving water bodies. USGS published the SPARROW model for the U.S. portion of the Lake Erie Basin in 2011. Additionally, Heidelberg University manages an extensive tributary monitoring program. Further discussion on tributary monitoring and the SPARROW model to determine total phosphorus loads to Lake Erie can be found in Appendix A.

The SPARROW model estimates the total U.S. load to Lake Erie, excluding contributions from Canada, Lake Huron, and atmospheric sources, as shown in Figure 1. The SPARROW model estimates long-term average phosphorus loads with inputs to the watershed similar to 2002 conditions. The Detroit River and Maumee River are the main contributors of phosphorus to the western basin. As noted previously, the Detroit Wastewater Treatment Plant is the main source of phosphorus for the Detroit River, while agricultural runoff is the main phosphorus input for the Maumee River. The role of dreissenid mussels, which filter lake water through their grazing of zooplankton yet also excrete phosphorus, may also contribute to nearshore algal blooms (LaMP, 2008a). Researchers from the Lake Erie Millennium Network Synthesis team found that during storm events, dissolved nutrients, such as DRP and nitrates, are present in high concentrations and are carried with storm runoff water well into the western basin where they are available to support HABs. Climate models suggest a 30%-40% increase in spring precipitation in the next century, which will likely result in increased phosphorus runoff and an increased prevalence of HABs (Scavia, 2012). There is debate in the scientific community about the estimated numbers in the SPARROW model; some experts suggest that the agricultural contribution is greater than what the model shows. The contributions of point and nonpoint sources remain a topic of debate among researchers, agency officials and Lake Erie stakeholders. Tributary and in-lake monitoring are needed to provide improved load information.

In the 1960s and 1970s, repeated lakewide monitoring provided the necessary data to determine whether water quality was improving or getting worse. A similar program for lakewide monitoring should be implemented today. Consistent, continuous Lake Erie water quality data impacts the ability of researchers, government agencies and interested stakeholders to understand the dynamic water quality conditions of Lake Erie. With this understanding, it may be possible to establish more meaningful nutrient reduction goals and attainment status measurements. Monitoring data and completion of a Lake Erie Management Assessment will provide a benchmark for determining whether Lake Erie's water quality, with regard to nutrients, is improving or deteriorating.

While great strides have been made to reduce wastewater system discharges, more needs to be done to ensure fertilizer and manure runoff, CSOs, sanitary sewer overflows (SSOs), and other discharges are reduced to meet Lake Erie's water quality needs. Despite variations among the estimated contributions of various point and nonpoint sources of phosphorus, it is obvious that point and nonpoint sources of phosphorus are important contributors of total nutrient loading to Lake Erie. The question of the exact mechanism and causes of the DRP increases remains unanswered; however, many stakeholders recognize the need to be proactive in implementing solutions while research and monitoring activities continue.





KEY TO RIVER/AREA

River/Area	River Name	River/Area	River Name	River/Area	River Name
DETROIT	ROUGE	MAUMEE	MAUMEE	E OHIO	VERMILLION
DETROIT	CLINTON	MAUMEE	TOUSSAINT	E OHIO	GRAND
DETROIT	BLACK	MAUMEE	OTTAWA	E OHIO	HURON
DETROIT	BELLE	SANDUSKY	SANDUSKY	E OHIO	CHAGRIN
DETROIT	PINE	SANDUSKY	PORTAGE	E OHIO	ASHTABULA
S MICH	HURON	SANDUSKY	MUDDY CR	E OHIO	CONNEAUT
S MICH	RAISIN	SANDUSKY	GREEN CR	OTHER	CATTARAUGUS
S MICH	STONY	CUYAHOGA	CUYAHOGA	OTHER	BUFFALO CR
S MICH	SWAN	CUYAHOGA	ROCKY	OTHER	EIGHTEENMILE
		CUYAHOGA	BLACK	OTHER	ELK

Figure 1. Long-term average phosphorus inputs (pounds) to Lake Erie by river/area (top) and source type (bottom). Source: Data from USGS Great Lakes SPARROW model, which includes the U.S. only and does not include CSOs. The USGS report uses inputs to the watershed similar to 2002 conditions.

1.4.2 Harmful Algal Blooms

Algae are a very diverse group of single and multi-cellular organisms that include groups such as green algae, cyanobacteria, and diatoms. Algae are an essential component of a healthy ecosystem. However, in excess or in certain forms, they can present many problems. HABs are defined as episodes during which large quantities of harmful forms of algae appear in the lake. HABs are caused by 6-7 species of cyanobacteria, also known as blue-green algae. Most of the time, small numbers of these cells are present, but under conditions of warm water temperatures (>60° F) and high levels of nutrients, the propogules resting on lake or river bottoms will bloom. While blooms of anabaena and aphanizomenon have occurred in Lake Erie, most of the blooms since the 1990s have primarily been the blue-green algae *Microcystis aeruginosa*. *Microcystis* can sometimes produce a toxin called microcystin, which has been implicated in animal illnesses and death as well as human illnesses, and rarely human death (Hudnell and Dortch, 2008). Microcystin poisoning can cause breathing problems, gastrointestinal discomfort, skin rashes, and liver damage. Cattle, wildlife, and domestic pet mortalities have been linked to microcystin, especially when ingested directly. Fish are impacted by microcystins at concentrations as low as a few micrograms per liter. Fish kills following a bloom are most likely caused by a combination of the direct effect of the toxins and the decreased oxygen and pH levels caused by the decaying blooms. Microcystin can even persist in water that has been boiled (Butler, et al, 2009). Additionally, increasing phosphorus concentrations promote the growth of the toxic strain of *Microcystis* (Davis et al., 2009). In 2011, scientists reported that *Microcystis* was arriving earlier in the lake and staying longer. The blue-green algae has also been found further upstream in the major tributaries and is ranging farther east in the lake, penetrating the central basin past Cleveland for the first time (Henry, 2011; Rousseau, 2012). The World Health Organization recommends microcystin not exceed 1.0 part per billion (ppb) for drinking water and 20.0 ppb for swimming. The highest level reported in Lake Erie was 1,000 ppb, recorded in July 2011 near the Toledo Lighthouse (National Oceanic and Atmospheric Administration [NOAA], 2011).

HABs have led to frequent water quality advisories (Source: Ohio EPA).


Satellite photo of Lake Erie during the 2011 algae bloom, a record year in which the bloom spread to the eastern basin (Source: USGS MODIS).

While nutrients are an important food source for all types of algae, the excess amount has caused a surge in HABs. In June and August 2009, the equivalent capacity of 110 million railroad coal cars of *Microcystis* was discharged to the lake from the Maumee and Sandusky Rivers each month (Culver and Conroy, 2011). While inputs of *Microcystis* do not always result in HABs, it is thought that river sources of algae may act as a “seed” for lake algae blooms (Bridgeman, 2012). Additionally, frequent and heavy storms sent a record 265 metric tons (292 tons) of phosphorus down the Maumee River to the Lake from April through May 2011. The 2011 bloom covered 1,600 miles (approximately 17%) of the western basin (Engel and Hunt, 2012). The algae bloom was over two feet thick in places (National Wildlife Federation, 2011). The 2011 bloom extended past the central basin and was 2.5 times the previous highs during the 21^{st} century (Reutter, 2012). A combination of factors, including preceding weather conditions, storm intensity, and water temperature, was found to contribute to the formation and size of HABs. Most of the Lake Erie research and management community agree that DRP is the major culprit fueling the increase in algal blooms seen since the mid-1990s.

Besides the ecological damage that HABs present, significant economic impacts have been felt. Boating, fishing, and swimming on Lake Erie are extremely important and there is evidence that algae is keeping people away from the coastal areas. The ODNR Division of Wildlife blamed the weather and algae for a loss of $1.2 million from 2010 to 2011 in fishing licenses sold (Morris, 2012). Charter boat captains reported a decrease in future bookings for fishing charters during the 2011 outbreak and they experienced shortened trips in recent years because of lake conditions (Henry, 2011).

Water treatment costs rise significantly for communities that draw Lake Erie water for their public water supply when HABs are present. There are 23 public water supply intake systems in Ohio's western and central Lake Erie basins (Ohio EPA, 2012). Western Lake Erie blooms affect approximately 613,000 residents using water from the Toledo, Oregon and Ottawa County Regional Water systems. The City of Toledo, with a water intake crib located three miles into the Lake, spent $3,000 to $4,000 per day on carbon activated filtration during blooms in 2010. Toledo incurred additional costs to treat the water with potassium permanganate. Such costs to communities throughout Lake Erie will only escalate if the blooms continue to begin earlier and stay later in the season.

The OSU Sea Grant recently commissioned a study to determine the impacts of HABs to businesses. Though we cannot yet place a value on the lost revenue, we know that the economic impact of algae blooms is widespread and includes the potential for increased health care costs, decreased property values, decrease in tourism, decrease in commercial and recreational fishing and boating, and increased cost of water treatment.

1.4.3 Microbial Contamination

A major human health concern related to recreational use of Lake Erie is microbial contamination through contact with polluted water. Various species of bacteria, viruses and protozoa can pose human health risks. Microbiological contamination can result from a number of sources, including sewage discharges, agricultural runoff, animal and pet waste, and urban runoff. Exposure to these organisms can cause gastrointestinal discomfort, respiratory illness, and skin reactions. In addition to the human health effects, beach warnings and closings associated with microbial contamination can result in economic impacts, including reduced tourism. Exceedances of bacteria such as *E.coli* continue to occur at Lake Erie beaches and other nearshore recreational areas. High levels of bacteria can threaten human health and keep people away from important tourist areas.

1.4.4 Sediments and Turbidity

An estimated 2.99 million metric tons (3.3 million tons) of sediment enters Lake Erie each year (NRCS, 2011). Lake Erie receives the highest sediment load of all of the Great Lakes (Richards, 2011). Further, the Maumee River discharges more tons of sediment per year than any other tributary of the Great Lakes. Much of this sediment load is delivered as a pulse in a small number of storm events annually. Sediment runoff occurs during heavy and widespread precipitation events as well as moderate storm events on frozen or saturated ground. The Ohio Lake Erie Commission adopted the Lake Erie Protection and Restoration Plan in 2000 that established a goal of reducing sediment delivered to the lake by 67%. Trends suggest that sediment runoff in the Maumee River and Sandusky River basins has decreased, while the Cuyahoga River basin has increased (Richards, 2011). Despite sediment reductions, sediment and associated nutrient runoff remain an issue for Lake Erie.

To keep all the major ports on the lake open, the U.S. Army Corps of Engineers (USACE), local governments and private industry dredge the federal and non-federal shipping channels to provide access to the cargo docks. Along with being costly, the dredge material presents many environmental challenges. In the western basin, most of the dredge material is released in the open-lake placement area; this is often called open-lake dumping. There are concerns regarding the environmental impacts of such a practice, including increased turbidity and nutrient re-suspension. In Toledo Harbor alone, over 800,000 cubic yards must be dredged annually to keep the channel navigable at a cost of over $5 million (USACE, 2012). Dredged sediment management is also an issue in Cleveland, where the existing capacity of the confined disposal area (CDF) must be managed to hold additional dredged material. Many Lake Erie stakeholders are working to evaluate alternatives to open-lake placement as well as to reduce the amount of sediment entering Lake Erie through conservation practices.

Lake Erie Top Aquatic Invasive Species

- White Perch
- Sea Lamprey
- Common Carp
- Spiny Euro Water Flea
- Fish Hook Water Flea
- Round Goby
- Quagga Mussel
- Zebra Mussel
- Eurasian Watermilfoil
- Purple Loosestrife

Source: Ohio Sea Grant, 2009

1.5 Invasive Species

Invasive species are plants and animals that are non-native to an ecosystem, or not originally from an area. Aquatic invasive species are often introduced in the Great Lakes through the ballast water of ships. Due to their aggressiveness and lack of natural predators, invasive species often reproduce quickly and out-compete many native species. Since the 1800s, over 182 invasive species have been introduced to the Great Lakes ecosystem, with over a third introduced since the 1960s (Michigan Department of Environmental Quality [MDEQ], 2011). Top invasive species in Lake Erie include the zebra and quagga mussels, round goby, spiny water flea, and sea lamprey. Despite improving water clarity, zebra and quagga mussels have changed the normal food web of the lake and are thought to facilitate the growth of cyanobacteria blooms and HABs (Conroy et al., 2005; Great Lakes Environmental Research Laboratory [GLERL], 2006). Zebra mussels also compete with a small crustacean known as *Diporeia*, which is an important part of the diet of smelt, whitefish and young lake trout. *Diporeia* are now completely absent from Lake Erie (Richard et al., 2011).

Lake Erie was found to be highly suitable for Asian carp species (Source: Great Lakes Fishery Commission, 2012).

The recent threat of Asian carp establishing reproducing populations in Lake Erie has become a primary invasive species issue. The general term of Asian carp includes silver, bighead and grass carp. Asian carp were introduced in the southern United States for use in aquaculture. The western Lake Erie ecosystem was found to be highly suitable for Asian carp and is therefore at great risk (Kocovsky et al., 2012). Further, water samples taken from Lake Erie's Sandusky and Maumee Bays in 2011 tested positive for Asian carp DNA, prompting concern from fisheries management agencies about the possibility of Asian carp in the lake (ODNR, 2012). As a follow up to those findings, ODNR conducted intensive electrofishing and gill netting activities in Sandusky Bay, Maumee Bay and their tributaries in July 2012. Results from this sampling indicate 20 of the 150 samples taken throughout Sandusky Bay and Sandusky River tested positive for the presence of silver carp DNA (ODNR, 2012). That number of positive samples was not expected and it emphasizes the need to understand the source of this DNA as soon as possible. DNA was also detected in three of 350 water samples collected from western Lake Erie's Maumee Bay and Maumee River between July 31, 2012 and August 4, 2012. All three positive results were from Maumee Bay, with one in Ohio and two in Michigan (ODNR, 2012). No Asian carp were found through electrofishing or netting. In response to these results, state and federal officials have begun collaborative discussions to begin additional investigations in September 2012 (ODNR, 2012). USACE and the USGS are leading a two-year Asian carp Environmental DNA (eDNA) Calibration Study that will investigate alternative pathways for eDNA detections beyond live fish.

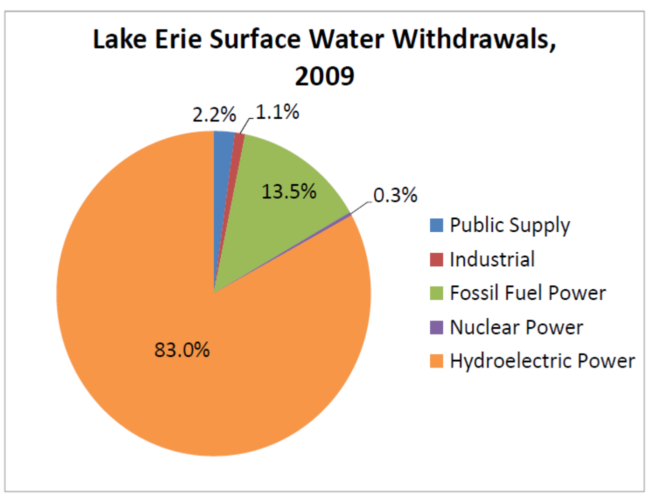
Invasive species control and prevention comes at a great cost. Great Lakes states spent nearly $31 million to address and combat aquatic invasive species in 2009 and 2010. It costs one Great Lakes power plant $1.2 million annually to monitor and control zebra mussels and one water treatment facility spent $353,000 on controlling zebra mussels. The cost of food fished from the lakes will also increase due to the trickle down of the costs of dealing with invasive species (The Nature Conservancy, 2012).

1.6 Other Issues Affecting Lake Erie

The issues discussed in the previous sections are considered the primary concerns for Lake Erie to be addressed by LEIA at this time. As such, the recommended actions in this plan will mainly focus on the issues presented in Sections 1.4 and 1.5. However, these issues are by no means the only ones facing Lake Erie. Other issues such as water supply and use (e.g., water levels and quantity), habitat loss, changing weather, and declining sport fish populations also threaten the health and use of Lake Erie. These issues are further discussed in this section.

1.6.1 Water Supply and Use

The Great Lakes hold 90% of the U.S. surface freshwater, which is used for public water supply, by industries and power generators, and for irrigation, livestock, and mining, among others. Each year, billions of gallons are pumped out. In 2009, over 480 billion gallons of water was withdrawn from the Great Lakes per day, with a consumptive use, or water not returned to the basin, of over two billion gallons per day (Great Lakes Commission, 2011). In Lake Erie, over 57 billion gallons of water was withdrawn from the surface and ground waters of the basin, with a half a billion gallons not being returned to the basin (Great Lakes



Data Source: Great Lakes Commission, 2012

Commission, 2011). While much of the water withdrawn from Lake Erie is returned to its source, sustainable water withdrawal remains an important issue.

Lake Erie provides drinking water to 11 million people, with 3,127 treatment plants withdrawing 437 million gallons per day (NRCS, 2005; Lake Erie LaMP, 2008). Additionally, more than 80% of Ontarians get their water from the Great Lakes (Ontario Ministry of the Environment, 2012). Thus, control measures at water treatment plants must be adequate to reduce the risk from exposure to microbes, toxins and pollutants. Ontario has been engaged in a process of source water protection through the 2006 Ontario Clean Water Act. Local conservation authorities were required to submit source protection plans by August 2012. These plans aim to keep source water safe by addressing potential pollutants (Ontario Ministry of the Environment, 2012). Protection and remediation of the water at its source is the key to maintaining quality drinking water supplies.

Industries use Lake Erie water in a variety of ways, including food processing, electronics, new material, and biotechnology manufacturing. Almost all manufacturing requires water in some capacity, with it being a critical component in some industries. Much of the Great Lakes and Lake Erie water is used for hydroelectric, fossil fuel and nuclear power generation (Great Lakes Commission, 2011). The eight Great Lakes states account for almost 40% of water use in the U.S. (Great Lakes Commission, 1992). Access to a high quality water resource such as Lake Erie can create an economic advantage to areas near the lake.

Given the multiple international and state boundaries, there is a need for collaborative effort regarding the management of the Great Lakes. To facilitate this, the Great Lakes–St. Lawrence River Basin Sustainable Water Resources Agreement was signed in 2005. This agreement provides a framework for the U.S. and Canada to work collaboratively to protect and manage this shared resource. In 2008, the U.S. states ratified the Great Lakes–St. Lawrence River Basin Water Resources Compact, which laid out the policies and practices by which the U.S. states adhere to their commitments under the Great Lakes–St. Lawrence River Basin Sustainable Water Resources Agreement. Michigan passed its water management program soon after, which features a water withdrawal assessment tool designed to estimate a withdrawal's impact on nearby stream and water bodies. However, there is concern about funding for Michigan's water withdrawal plan management. Despite a fee for users withdrawing more than 1.5 million gallons per year, there is a significant loophole for agricultural users, resulting in the MDEQ's water use program being severely underfunded (Gosman, 2011). New York passed legislation regarding water use and management in August 2011, with the legislation taking effect February 2012. Ohio's water use and management program, House Bill 473, was signed into law on June 5, 2012 amid significant debate. A previous version was passed by the Ohio legislature, but was later vetoed by Governor John Kasich. This agreement becomes fully binding in 2013, when all states must have developed and adopted water use and management regulations.

1.6.2 Habitat Loss

The degradation and elimination of habitats such as forests, wetlands, and grasslands have had a marked effect on the Lake Erie basin. The Lake Erie basin has lost over 80% of its coastal wetlands due to urbanization and conversion to agricultural lands and there remains concern over the incremental loss and degradation of habitat around the watershed (Lake Erie LaMP, 2008). Much of the Maumee River watershed contained a vast wetland community, called the Great Black Swamp. This area was drained extensively with the installation of ditches between the 1780s and 1980s, with only 5% of the habitat remaining. Even though productive farmland was gained, there was a huge loss of wetland functions such as nutrient and sediment storage and cycling, storm water control, and fish and wildlife habitat. Protecting the remaining habitat, as well as restoring habitat, is a priority in the Lake Erie basin.

1.6.3 Changing Weather and Climate

The Intergovernmental Panel on Climate Change concluded that warming of the earth is occurring, and that the changing climate could have a wide range of effects on many ecological and environmental components of the Great Lakes system, including an increase in overall air temperatures, decrease in daily temperature ranges, increased severity and frequency of storms, and less ice cover (Parry, 2007). Weather events are predicted to be more extreme, with flashier weather and heavier storm events leading to increased runoff of sediment and nutrients.

Climate change is likely to favor HABs through higher amounts of rain in shorter time periods, higher water temperatures, extended growing season, and other physical impacts on the lake that favor cyanobacteria (Paerl et al., 2011). Some climate change predictions are already evident, with record extreme weather events being documented in the last five years. Between the 1970s and 1990s, ice cover on Lake Erie decreased 17% (MDEQ, 2011). During winter 2011-12, the lake never entirely froze over. While reversing climate change is a significant challenge, adaptive management actions to mitigate climate change impacts may be necessary in the Lake Erie region.

1.6.4 Declining Sport Fish Population

Native fish stocks have decreased in the last century due to overharvest, habitat loss and invasive species (Great Lakes Fishery Commission [GLFC], 2007). Walleye abundance in Lake Erie was low in the 1970s and mid-1980s. After successful remediation efforts, walleye populations rebounded and peaked in the late 1980s. Between 2000 and 2003, walleye abundance fell, with the population temporarily rebounding in 2004 and 2005. There has been a steady downward trend since, with 2010 walleye abundance the lowest since 1978 (MDEQ, 2011). The GLFC Lake Erie Task Force estimated that the lake now has 28 million fewer yellow perch than in 2010 and the walleye population has decreased from 2.9 million in 2010 to 2.2 million (Henry, 2011). In 2011, the total sport harvest for private fisheries was 4.9 million fish and 3.2 million pounds of fish for charter fisheries, with yellow perch making up the majority of the catch (ODNR, 2012). Since 2003, Ohio sport fish populations have declined due to below average hatches (ODNR, 2009). The success of fish populations is dependent on a variety of factors including water quality, habitat, invasive species, and success of stocking. Fish and wildlife experts warn that as water quality in Lake Erie deteriorates from algae, the number of walleye, yellow perch and bass will decline while the less desirable fish such as carp, white perch and shad will increase (Knight, 2012).

SECTION 2: LAKE ERIE IMPROVEMENT ASSOCIATION (LEIA)

2.1 LEIA Mission

LEIA is a Lake Erie watershed-wide economic sustainability initiative dedicated to healthy waters and fish by promoting cooperation and wise resource management for the benefit of the Lake Erie basin.

The goal of LEIA is to reduce nutrient loading into Lake Erie and to help address other Lake Erie challenges. LEIA bridges the gap between public and private Lake Erie stakeholders using a business model approach. LEIA is uniquely positioned as the organization that speaks for healthy Lake Erie-dependent businesses to promote economic sustainability.

2.2 Governance and Management Structure

LEIA adopted bylaws in 2011 that govern the organization. LEIA is a stand-alone organization with its own board to select projects and direct resources. LEIA membership is open to everyone with payment of annual dues. It has its own checking account and accounting system. LEIA is hosted within Lake Erie Waterkeeper Inc., a 501(c) 3 organization, which administers LEIA for a 10% fee. Waterkeeper provides staff support to LEIA, insurance for its directors and officers, web site coordination and updates, and accounting functions. LEIA is led by a commission, comprised of a president, vice president, secretary, treasurer, sergeant at arms, and several at-large commission members. Commission members serve two year rotations.

2.3 Current Roles

The LEIA Commission meets every month to discuss the status of Lake Erie impacts, discuss studies and actions to improve the lake, identify opportunities for advocacy and action to promote and fix the lake, and to discuss LEIA-specific functions such as fundraisers, web sites, and other activities. LEIA has several committees that meet regularly.

- <u>Agriculture Committee</u> – addresses agricultural nutrient runoff, fertilizer and manure runoff, and other issues.
- <u>Water/Wastewater Committee</u> – addresses municipal water and wastewater plants, including the effects of algae on municipal water supplies. This committee will eventually address septic systems and include local health departments.
- <u>Lake Erie Fundraising/Events Committee</u> – addresses ways to partner with Visitors Bureaus, Chambers of Commerce and other organizations that promote the lake through advertising, special events and other activities. The goal of this committee is to strengthen awareness of the importance of Lake Erie. While the other committees focus mainly on improving the lake, this committee is focused on promoting the lake. This committee also addresses raising money for the continued success of LEIA as well as to accomplish specific LEIA missions.
- <u>Legislative Committee</u> – addresses local, state, and federal legislation related to Lake Erie. This committee takes the lead on potential legislative actions and is a liaison between the LEIA and lawmakers.

LEIA sponsored a kick-off meeting at Camp Perry in Port Clinton, Ohio in June 2011, where over 100 people attended. Attendees were assigned to breakout groups based on their areas of interest and expertise. Time was spent at the forum brainstorming potential issues/opportunities/actions, implementation strategies, resources needed, and recommended leaders to implement the recommendations. This event, funded by the Gund Foundation, was considered very successful and resulted in the development of specific recommendations to improve Lake Erie. Many of the recommendations gathered at this forum are included in this Strategic Plan.

Ohio EPA and ODNR designated LEIA and its commission members to represent the Lake Erie business community. All parties participate in regularly scheduled calls with the Ohio EPA Director and the ODNR Chief of the Division of Soil and Water Resources. During these calls, lake impacts, opportunities for improvement, information needs, resource allocation, and collaboration opportunities are discussed. These calls began in early 2012 and have already proven to be informative and helpful in establishing a common understanding of issues and concerns and in identifying opportunities for resource sharing, funding allocation and personnel efficiencies.

LEIA advocated that Ohio EPA take an active role in the Detroit Wastewater Treatment Plant permitting process in 2012. This work resulted in Ohio EPA and LEIA getting a seat at the table to provide input into the permit renewal activities that will result in the plant meeting more stringent standards and being more accountable for nutrient discharge, sludge management and other plant processes.

LEIA worked with state legislators to advocate the establishment of the new Healthy Lake Erie Fund that was passed by the Ohio Legislature in summer 2012 providing $3 million in funding for Lake Erie improvement projects.

2.4 Potential Roles

LEIA anticipates maintaining and expanding its role as a Lake Erie economic advocate focused on smart approaches to understand and address nutrient impacts and other Lake Erie challenges. As this strategic plan is implemented, it is anticipated that LEIA's membership and influence will continue to grow.

LEIA will implement appropriate portions of the plan via association staff, hired consultants or team members. For those actions not completed by LEIA members, LEIA will partner with other organizations or individuals. In those cases LEIA will share its recommended actions with those organizations to ensure their understanding and commitment to implement our recommendations and will empower them to complete activities. Regular status updates will be completed to ensure timely plan implementation. LEIA will maintain and increase its role as the Lake Erie representative for the business and economically impacted community as a Lake Erie advocate as well as serve the important function to help exchange and disseminate relevant Lake Erie water quality-related information to stakeholders and basin citizens.

LEIA anticipates serving a variety of roles:

1. Strategic Plan Implementer
    a. Implement certain actions not being completed by others via association staff, hired consultants or team members;
    b. Advocate for and empower other organizations to implement actions;
    c. Monitor the committed actions of the various governmental agencies; and
    d. Review progress of Strategic Plan to ensure timely plan implementation and complete regular plan updates.

2. Lake Erie Business Community Representative/Advocate

3. Lake Erie Information Exchange/Dissemination Provider

SECTION 3 – STUDIES AND ACTIONS

3.1 Lake Erie Studies and Actions

Many studies and actions have been undertaken by a variety of stakeholders, including governmental and public agencies, non-profits, and universities, to monitor and address Lake Erie issues. While the list and descriptions included in the following sections are by no means comprehensive, they address many of the major ongoing or current Lake Erie studies and actions and are useful for LEIA to better understand the existing organizations and efforts underway, to provide the opportunity for input and support where appropriate, and to help identify programmatic gaps or opportunities to adjust programs to accomplish additional objectives.

3.1.1 International

<u>IJC Lake Erie Ecosystem Priority (LEEP) Project</u> – As part of the Lake Erie Ecosystem Priority Project, the IJC will complete a number of review papers that discuss a wide range of Lake Erie issues, such as nutrient loadings and key indicators, assessment of the adequacy of monitoring programs within Lake Erie, economic impacts of HABs, and recommended social/economic solutions. As part of this project, the IJC will develop recommendations on restoring the health of Lake Erie through reductions in nutrients, specifically DRP. This project includes a review of the current science and socio-economic impacts associated with phosphorus and HABs. Recommendations are expected to be presented to the governments of the U.S. and Canada in early 2013, with opportunity for public comment in spring 2013. A final report is expected to be presented to the governments in October 2013.

<u>Great Lakes Water Quality Agreement (GLWQA)/Protocol</u> – The GLWQA, signed in 1972, affirms the commitment of Canada and the U.S. to protect and restore the biological, chemical and physical integrity of the Great Lakes. The 1978 revision set goals and objectives to achieve this commitment, including phosphorus targets for wastewater plants in Lake Erie and Lake Ontario and for total phosphorus in Lake Erie. In 2010, negotiations began to revise the 1978 version. The Great Lakes Water Quality Protocol of 2012 was signed on September 7, 2012 with new provisions to address the nearshore environment, aquatic invasive species, habitat degradation, and the impacts of climate change. The agreement lays out several Lake Erie goals, including minimizing the hypoxic zone, maintaining algal levels below the level constituting a nuisance condition, and maintaining a mesotrophic condition in the western and central basin and oligotrophic condition in the eastern basin. The agreement sets a total P load for Lake Erie at 11,000 metric tons (12,125 tons) per year and a total phosphorus concentration, as represented by average spring season measurements, of 15 ug/l for the western basin, and 10 ug/l for the central and eastern basins, on an interim basis until these substance objectives are updated. The agreement also has phosphorus limit goals for Lake Erie and Lake Ontario for wastewater plants at 0.5 .mg/l for plants over one million gallons a day and at 0.1 mg/l for those with less than one million gallons per day. The protocol also stipulates that the U.S. and Canada determine appropriate phosphorus loading allocations by country. The protocol specifies that the bioavailability of various forms of phosphorus, related productivity, seasonality, fisheries productivity requirements, climate change, invasive species, and other factors be taken into account when the loading targets are updated. These updates are to be completed within three years of entry into the agreement (Great Lakes Water Quality Protocol, 2012).

<u>Lake Erie LaMP</u> – As part of the 1978 Great Lakes Water Quality Agreement, U.S. and Canadian parties agreed to complete a lakewide management plan (LaMP) for Lake Erie. This

plan, last updated in 2008, identifies critical pollutants and develops recommendations for addressing the impairments. The Ohio Environmental Council currently facilitates the Lake Erie LaMP through webinars, meetings, and list-servs.

Areas of Concern (AOCs) - AOCs are areas with severe environmental degradation that fail to meet conditions of the Great Lakes Water Quality Agreement. The following AOCs are located in Lake Erie: Ashtabula River, Ohio; Black River, Ohio; Clinton River, Michigan; Cuyahoga River, Ohio; Detroit River, Michigan; Maumee River, Ohio; Presque Isle Bay, Pennsylvania; River Raisin, Michigan; Rouge River, Michigan; and St. Clair River, Michigan. Remedial Action Plans (RAPs) were developed and are being implemented for each of these AOCs to address and restore the various Beneficial Use Impairments (BUIs).

3.1.2 Federal

Great Lakes Restoration Initiative (GLRI) – In 2005, the Great Lakes Regional Collaboration Strategy to Restore and Protect the Great Lakes called for $20 billion to restore and protect the Great Lakes (Healthy Lakes, 2012). Initiated in 2010, the GLRI is one of the largest investments in the Great Lakes in over 20 years. This program provides funding to address a variety of focus areas included in the GLRI Plan, including toxics and areas of concern, habitat protection and restoration, nearshore health and nonpoint source pollution, and invasive species. In the first two years of the program, over 600 projects have been initiated to restore the health of the Great Lakes (U.S. EPA, 2012).

U.S. EPA Great Lakes Advisory Board (GLAB) - In May 2012, the U.S. EPA announced the creation of a Great Lakes Advisory Board. The purpose is to support U.S. EPA with the implementation of the GLRI and the GLWQA. It is anticipated that a range of interests such as environmental groups, agricultural groups, businesses, universities and others will be represented. The GLAB is expected to meet twice a year, with additional conference calls as necessary.

National Oceanic and Atmospheric Administration – NOAA Great Lakes Environmental Research Laboratory (GLERL) is involved in many Lake Erie issues, from determining phosphorus load limits to investigating the effects of invasive species. Their 2012 Strategic Plan outlines short-term and long-term focus areas and actions, such as investigating the impact of the central basin's hypoxic zone effect on drinking water resources, climate change impacts, and decreased ice cover impacts. Also, NOAA currently prepares and distributes the Lake Erie HAB bulletin that provides a weekly forecast of current and future algal blooms, including the intensity and type of bloom (harmful or non-harmful).

United States Geological Survey – The USGS is involved heavily in various Lake Erie research and management issues. The Great Lakes Science Center provides critical research for the sound management of the Great Lakes. The USGS is also part of a team investigating the use of satellite imagery to monitor HABs.

Ballast Water Regulations - Water is taken in and stored in ballast tanks to assist ships with stability during transportation. Ballast tank water is then released at the destination port of call. Invasive species prevention through regulation of ballast water is a key component in the fight against invasive species in Lake Erie. In 2009, the U.S. Coast Guard proposed new regulations to require vessel operators to install ballast water treatment technology starting in 2016. The final rule was published in March 2012. The State of New York dropped efforts in 2012 to pass ballast water regulations that were much stricter than the current international regulations. Instead, U.S. EPA passed federal ballast water regulations months later, which were met with opposition by conservation groups who argued that the regulations did not go far enough to protect against invasive species.

Asian Carp Regional Coordinating Committee – This committee was formed in 2009 to address the threat of Asian carp invasion in the Great Lakes. Several federal, state, and local agencies are committee members, with the White House Council on Environmental Quality's Asian carp Director leading the effort. This group was tasked with creating a sustainable strategy to prevent the introduction of Asian carp in the Great Lakes basin.

USACE Great Lakes and Mississippi River Interbasin Study – The USACE, in consultation with various federal, state and local agencies and stakeholders, is conducting a study to investigate various options and technologies to prevent the spread of aquatic nuisance species between the Mississippi River and Great Lakes basins. In July 2012, the U.S. Congress passed a transportation bill that included a requirement that USACE speed its work of this project, which was originally scheduled to be completed in 2015. USACE now has until January 2014 to finalize recommendations to prevent the spread of invasive species between the two basins.

Western Lake Erie Basin (WLEB) Partnership – The WLEB Partnership was formed in 2006 by USACE and NRCS, and includes over 14 federal, state and local agencies in Ohio, Michigan and Indiana. The goal of the WLEB is to create a comprehensive watershed management partnership and framework for the basin. Funding will be necessary to ensure this partnership continues.

Canadian Actions and Studies – The Province of Ontario and various Canadian entities are addressing many Lake Erie issues, including phosphorus and algae issues. Environment Canada conducts the Great Lakes Surveillance System, which monitors water quality in the Great Lakes and has been in operation for over 40 years. Further, the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem discusses the various responsibilities of provincial and federal ministries, as well as helps Canada meet its obligations under the GLWQA. Canada is also heavily involved in the Lake Erie LaMP process. More details on programs specific to the Province of Ontario are included in Section 3.1.3.6.

3.1.3 State/Provincial

3.1.3.1 State of Ohio

Healthy Lake Erie Fund/Ohio Clean Lakes Initiative – In July 2012, the State of Ohio announced the Ohio Clean Lakes Initiative, which aims to improve water quality and reduce HABs in the western Lake Erie basin. As part of this program, funds from the recently created Healthy Lake Erie Fund are expected to be used to address nutrient runoff on agricultural lands and monitoring. The State of Ohio budgeted $3 million for FY13 to help fight the HAB problem through the Healthy Lake Erie Fund, which will be administered by the ODNR.

Toledo Harbor Task Force Dredged Sediment Management and Use Plan – The Ohio Lake Erie Commission was awarded Great Lakes Restoration (GLRI) funding in 2010 to complete a dredged sediment management and use plan that identifies and prioritizes practicable, economically-sound and environmentally-acceptable options, which address short-term (1-5 years) and long-term (30-year) options regarding the management of dredged sediment from Toledo Harbor. The final plan will be completed in late 2012.

Cleveland Harbor Sustainable Sediment Management Strategies – The Cleveland-Cuyahoga County Port Authority is leading an effort to develop strategies to manage sediment runoff into the Cuyahoga River and material dredged from the federal navigation channel. The USACE is evaluating whether sediment meets guidelines for open-lake placement.

The 4R Nutrient Stewardship - The 4Rs is a nutrient management strategy that advocates applying the right fertilizer source at the right rate, at the right time, in the right place. The Ohio Department of Agriculture, Ohio EPA, and ODNR's "Director's Agricultural Nutrients and Water Quality Working Group" report recommended that this nutrient management strategy be incorporated into Ohio's strategy to address algal blooms (ODNR, 2012).

Ohio Phase II Phosphorus Task Force - The State of Ohio is currently completing Phase II of the Ohio Phosphorus Task Force, funded by a 2011 U.S. EPA GLRI grant. As part of this project, current research findings will be incorporated into a broader consensus on potential management strategies necessary to address the HABs in western Lake Erie. The Phase II project will also develop a consensus on a reduction target or goal for phosphorus.

Ohio EPA Nearshore Monitoring – Ohio EPA began expanding the nearshore monitoring program in 2011, as part of a GLRI-funded project. This allowed for expanded data collection at a number of Lake Erie sites (Ohio EPA, 2012). Additionally, Ohio EPA teamed with the Lake Erie Charter Boat Association to expand lake sampling by having charter captains assist the state in collecting water samples in upcoming years.

Ohio EPA Nutrient Strategy – Ohio EPA submitted a draft nutrient reduction strategy to U.S. EPA in November 2011. This framework is part of an effort to reduce nutrient impacts in Ohio's waters and involves multiple agencies seeking input from stakeholder groups. The framework is currently under review by U.S. EPA.

Western Lake Erie Basin Total Maximum Daily Load (TMDL) – Due to the multiple state and international jurisdictions associated with Lake Erie, Ohio EPA placed a low priority on completing a TMDL for the lake (Ohio EPA, 2012). In October 2011, Ohio EPA sent a letter to U.S. EPA requesting that U.S. EPA complete a TMDL for the western Lake Erie basin. The U.S. EPA is currently considering this request. If completed, the western Lake Erie TMDL would be the largest, surpassing the Chesapeake Bay watershed TMDL. The TMDL would supply needed data for improved decision making in the western basin and Lake Erie as a whole. Support from the State of Michigan will be needed to complete a western Lake Erie basin TMDL.

Ohio Department of Health - The Ohio Department of Health assists with notification of HAB and *E. coli* beach advisories. It is installing infographic signs during the summer season at beaches to inform the public about HABs and update them on the current advisory category. Updated beach information can also be found on the website www.ohioalgaeinfo.com, which is part of a cooperative effort with Ohio EPA and ODNR.

Ohio Lake Erie Commission Lake Erie Protection & Restoration Plan (LEPR) 2008 – The LEPR outlines goals and actions that the Ohio Lake Erie Commission and its member agencies will take toward protecting and restoring Lake Erie and its watershed, including addressing nonpoint source pollution, invasive species, water withdrawals, climate change, and habitat and species. The last update to the LEPR was completed in 2008, with action items targeted for FY 2010-2011. This plan is expected to be updated by June 2013.

3.1.3.2 State of Michigan

The State of Michigan is an active participant in seeking solutions to Lake Erie nutrient problems. MDEQ formed a Phosphorus Policy Advisory Committee in 2006, which was charged with identifying major sources of phosphorus loading in the state and to review the voluntary and regulatory mechanisms that are being used to address major source categories, as well as future mechanisms. Michigan completed the Michigan Great Lakes Plan in 2009, which lays the groundwork to preserve, restore, and sustain Michigan's Great Lakes. The plan focuses on specific needs, strengths and challenges of Michigan in relation to the Great Lakes.

3.1.3.3 State of New York

While New York is largely removed from the algal bloom problem, they continue to address pollution, fishery, and other Lake Erie issues. New York has been a leader in researching botulism in Lake Erie. Representatives from New York participate in many of the Lake Erie partnerships, including the Lake Erie LaMP.

3.1.3.4 State of Pennsylvania

In Pennsylvania, water pollution issues fall under the jurisdiction of two bureaus within the PA Department of Environmental Protection (DEP), the Bureau of Point and Non-Point Source Management, and the Bureau of Conservation and Restoration. They have a goal of restoring 700 bodies of water by 2012 for sediment and nutrient pollution problems. They are also charged with implementing Watershed Implementation Plans (WIP) such as the one described in Section 3.2.1 for Chesapeake Bay. To date, all 33 WIPs throughout PA have been completed and accepted by the U.S. EPA.

3.1.3.5 State of Indiana

The State of Indiana has no shoreline on Lake Erie, but still plays a significant role in Lake Erie water quality because of the headwaters of the Maumee River, a major Lake Erie tributary. These headwaters are in Fort Wayne, Indiana where the 99-mile long St. Marys River, which originates in Ohio, meets the 86-mile long St. Joseph River, which originates in Michigan, to form the headwaters of the Maumee River. Because of the nutrient and sediment load in the Maumee River, Indiana's involvement through the St. Marys, St. Joseph and upper Maumee rivers is key to improving the Maumee River and thus Lake Erie water quality.

Forty-eight impairments were noted in the TMDLs for the St. Marys/Maumee River watershed located in northeast Indiana, which were established in August 2006 after a two-year, extensive sampling, monitoring and analysis effort. Indiana is involved in the Western Lake Erie Partnership.

The Indiana Department of Environmental Management (IDEM), Division of Water established a goal to reduce TP to 0.076 mg/l by 2025. Point and nonpoint sources of nutrients are included. Milestones for agriculture include enrolling 500 acres in best management practices (BMPs) by 2015. The 2015 Urban milestone goal is to install 30 rain gardens on private property. Management of these nonpoint sources of pollution is mostly voluntary.

3.1.3.6 Province of Ontario

Ontario Ministry of the Environment Nutrient Management Act – The goal of this act, passed in 2002, is to protect waterways from agricultural pollution by regulating how nutrients are stored and applied. Regulations include restrictions on applying nutrients within certain distances of water bodies. Although winter application is allowed, restrictions are in place depending on whether the ground is snow covered, saturated or frozen.

Ontario Ministry of the Environment Great Lakes Protection Act – In June 2012, the Great Lakes Protection Act was introduced to the Legislative Assembly of Ontario. If passed, the act would authorize the Minister of the Environment to set targets and implement initiatives to address an array of Great Lakes problems. The Great Lakes Community Action Fund would accompany this act, which would provide grant funding to community groups to implement projects around the Great Lakes.

Government of Ontario Draft Great Lakes Strategy – In June 2012, the Government of Ontario drafted a Great Lakes Strategy, which outlines the actions the Province of Ontario would take to address Great Lakes issues. In October 2012, the Honourable Peter Kent, Canada's Environment Minister, announced an important investment over four years to address the complex problems of recurrent toxic and nuisance algae, and nearshore water quality and ecosystem health in the Great Lakes. The $16 million Initiative will focus efforts geographically on Lake Erie.

3.1.8 Universities

Heidelberg Tributary Loading Program – Heidelberg University's National Center for Water Quality Research (NCWQR) operates the Tributary Loading Program, which is integral in providing nonpoint source pollution data across the Lake Erie basin. The NCWQR's Lake Erie tributary monitoring provides the longest and most comprehensive set of nonpoint source pollution data across a river system in the U.S. Continued operation of this program is integral in the monitoring of current and future conditions of Lake Erie and its tributaries.

Ohio Phosphorus Risk Index – In August 2012, the Ohio State University and project partners received funding to evaluate the Ohio Phosphorus Risk Index and revise it as necessary based on field-scale, edge of field studies. It is expected that additional BMPs will be integrated into the index. Additionally, an interactive, user-friendly geographic information system (GIS) based database will allow producers to calculate their expected P Risk Index. While this work includes the entire state, the agricultural areas of the Lake Erie basin will be a critical component.

Ohio Sea Grant/Lake Erie Millennium Network Synthesis Team - The Lake Erie Millennium Network Synthesis Team is a multi-organization, international group that works to enhance the value and impact of Lake Erie research projects, improve management decisions, identify new research priorities, and clearly and concisely synthesize/summarize the results of research projects and state agency implementation and management projects for managers, decision makers, elected officials, and the public.

In June 2011, 15 researchers from 11 universities, institutions, and companies[2] representing the Lake Erie Millennium Network, submitted a final report titled, "Lake Erie Nutrient Loading and

[2] Universities, institutions, and companies that participated in the LEMN Synthesis Team include: The Ohio State University, University of Windsor, LimnoTech, Inc., Kent State University, Heidelberg University, University of Toledo, USDA Natural Resource Conservation Service, Defiance College, and Buffalo State College.

Harmful Algal Blooms: Research Findings and Management Implications." This report discusses the latest research involving nutrients, algal blooms, and agriculture and the implications on potential management actions. The report provides 18 specific recommendations for further research, including edge of farm field studies, tile drainage studies, and monitoring.

3.1.9 Non-Governmental Organizations

There are many organizations working toward improved water quality in the Great Lakes basin. We do not intend for this section to be a comprehensive list of those organizations; such a list could perhaps be available upon request by the Great Lakes Information Network. Included in this section are a few key organizations directly applicable to LEIA's strategic plan.

Healing Our Waters – Great Lakes Coalition (HOW) – HOW consists of more than 115 environmental, outdoor recreation and conservation organizations. HOW is a major leader in advocating for Great Lakes Restoration Initiative funding. HOW started with a $5 million grant from the Peter Wege Foundation. Its members share a common goal of protecting and restoring the Great Lakes. The coalition is led by the National Wildlife Federation and the National Parks Conservation Association and is instrumental in securing funding and lobbying for legislation that protects and restores the Great Lakes. HOW is also one of the organizers of Great Lakes Day in Washington D.C. that connects hundreds of Great Lakes representatives with Congressional members to discuss and promote policies which protect and restore the lakes, and also organizes the annual Great Lakes Restoration Conference, drawing together hundreds of NGO members, agency staff, researchers, and others.

Ohio Environmental Council (OEC) – The OEC has over 100 affiliate organizations, including universities, nonprofits and watershed groups, and over 3,000 individual members. The mission of the OEC is to "secure healthy air, land and water for all who call Ohio home." Through collaboration with a variety of both traditional and non-traditional stakeholders, the OEC works on public policy with a focus on the local and state level. The OEC also spearheads the Lake Erie LaMP, discussed in Section 3.1.1.

Ohio Farm Bureau – The Ohio Farm Bureau Federation (OFBF) is a nonprofit, grassroots agricultural advocacy organization of more than 214,000 family members. With headquarters in Columbus, Ohio, OFBF is a federation of 87 county Farm Bureaus. Each has its own board of trustees and volunteers who lead local initiatives. The mission of Ohio Farm Bureau Federation is to forge a partnership between farmers and consumers. This means advocating for Ohio's farm families on issues that help them in business and in turn provide consumers a wide variety of food choices. OFBF members believe that people have the power to shape the world in which they live. And that when they're given a place where they can work together, they have the ability to solve their own problems. OFBF exists so people can put ideas into action and bring about a better, more secure way of life.

The Nature Conservancy's Lake Erie Biodiversity Strategy Blueprint - This project incorporates a multi-stakeholder partnership to develop long-term strategies to conserve the aspects of Lake Erie that represent the biodiversity of the lake (e.g. species, systems, processes). The final strategy blueprint is expected to include critical threats to biodiversity, as well as objectives and actions to protect it, and measures to determine whether the actions are achieving their purpose. The final plan was released in December 2012.

Lake Erie Waterkeeper – The Lake Erie Waterkeeper first joined the Waterkeeper Alliance in 2005 as the Western Lake Erie Waterkeeper. In 2011, it expanded lakewide and now represents the entire Lake Erie community. This group is committed to protecting Lake Erie waters from pollution and other issues as well as to preserve and enhance fish populations.

3.2 Other Lake or Watershed Studies to Consider

LEIA was modeled after the Lake Improvement Association at Grand Lake St. Marys, Ohio's largest inland lake. In 2010, warnings were posted not to boat or recreate in Grand Lake St. Marys because of toxic algae. Rather than pointing fingers, the businesses and residents came together with elected and administrative officials to help the lake. They developed a plan and conducted an economic analysis of what the lake meant to the area economy. They hold open meetings and seek solutions. Solutions have come from both government and private businesses. Approximately 75 business proposals for water quality improvement projects were sent to Battelle for evaluation with six proposals selected based on anticipated costs and effectiveness.

We can learn from other lake restoration efforts as well. Described below are other large multi-stakeholder efforts underway to reduce nutrient loads and restore lakes.

3.2.1 Chesapeake Bay, United States

U.S. EPA, in collaboration with the District of Columbia, Maryland, New York, Pennsylvania, Virginia and West Virginia, established a TMDL for the Chesapeake Bay in 2010. Planning for this document was in process since 2005 and was also in response to the President's 2009 Executive Order to restore and protect the Bay as well as the failure of over 20 years of previous programs to address and mitigate the poor water quality in Chesapeake Bay and its tidal tributaries. This TMDL was the largest ever developed by U.S. EPA and identifies the need for pollution reduction of nitrogen, phosphorus and sediment across all the jurisdictions mentioned above. It is designed to ensure that all pollution control measures are in place by 2025 and that it is 60% complete by 2017. Each state and the District of Columbia were required to submit a Watershed Implementation Plan (WIP) that detailed how and when they will meet pollution allocations. These serve as "road maps" for when and how a jurisdiction plans to meet its pollutant allocations under the TMDL. U.S. EPA worked closely with each entity to revise and strengthen the plans. Highlights of these plans include regulating point and nonpoint sources of nutrients and sediments, more stringent limits at WWTPs, implementing progressive stormwater permits, and consideration of mandatory programs for agriculture by 2013 if pollution reductions fall behind schedule. U.S. EPA will conduct oversight of the progress of WIPs toward meeting the two-year milestones inherent in all programs.

Anticipating the impending TMDL, the University of Maryland, College of Agriculture and Natural Resources, set out to evaluate the progress made to date in reducing nutrients in the Chesapeake Bay watershed in 2009. Their approach included reevaluating soil phosphorus levels using GPS grid sampling on a field-by-field basis, reevaluating stream baseflow nitrate concentrations, constructing a land use implementation timeline in a major tributary, and evaluating whether sequential GPS-based soil sampling and stream baseflow nitrate sampling are practical monitoring tools. These actions were undertaken because even after more than a 20-year effort to reduce nutrient inputs to Chesapeake Bay, little progress had been made in reducing losses from cropland, especially with regard to phosphorus losses. This created doubt that current voluntary nutrient reduction strategies can achieve the nutrient reductions necessary to restore the Bay and created more pressure for regulatory approaches. It also suggested that before changes in these strategies are made, it would be important to develop methods to allow for accurate assessments of actual changes in nutrient levels to determine whether adjustments would be necessary or more time would be needed for policy changes (Staver, 2009).

One of these strategies was to create a nutrient mass balance report to help guide nutrient management planning and policy initiatives at all levels (farm, watershed, state, and regional scale). The strategy was used by the Delaware Nutrient Management Commission (DNMC). In 2009, the University of Maryland set out to develop a similar program for Maryland. The mass balance concept creates a system where the nutrient inputs should match the nutrient outputs to the area of interest. Nutrient surpluses indicate the potential for loss to the environment. It was hoped that the final report would encourage an initiative similar to the DNMC report where new policy was developed to move nutrient management forward (McGrath, 2009).

There have been over 40,000 TMDLs completed throughout the U.S., but the 64,000 square mile Chesapeake Bay watershed plan is the largest and most complex. Not only will the Bay benefit from the TMDL, but it will also have a positive impact on the thousands of streams, creeks, lakes, and rivers throughout the region. Development of the plan had to be done in an equitable manner. Allocations of nitrogen and phosphorus loading were based on the tributaries that contributed the most to the problem. Allocations needed to protect the living resources of the Bay and its tributaries and meet water quality standards for dissolved oxygen, chlorophyll a, water clarity, and underwater grasses. All tracked and reported reductions are credited toward achieving final assigned loads.

The Chesapeake Bay TMDL has a unique accountability structure that includes the WIPs, two-year milestones, tracking and assessment of restoration progress and federal contingency actions if necessary. The two-year milestones began in 2012. U.S. EPA will review these through the Tracking and Accountability System and determine whether they are sufficient to achieve the necessary pollution reductions. If they are not, U.S. EPA is committed to taking appropriate contingency actions to ensure the nutrient pollution reductions. Federal oversight will be especially strong during the two-year milestones and refinement of the TMDL in 2012 and 2017. The states and District of Columbia were required to submit Phase II WIPs in 2011 and Phase III WIPs in 2017. These will ensure that the 2025 goals are met. Even though there is a strong federal oversight component to this program, jurisdiction-based implementation of the policies and programs are the drivers and the key to reducing the nutrient pollution in the water (U.S. EPA, 2010).

In response to the TMDL, Virginia passed a law in 2011 that banned the use of phosphorus in fertilizers for homeowner yards and lawns. The Chesapeake Bay Foundation estimates that by 2013, the law could reduce Virginia's share of phosphorus pollution by 230,000 lbs./year, which equals 22% of their phosphorus reduction goals for the 2017 milestone. The legislation also requires labeling on fertilizer sold for home use that describes how to use the product. It would also prohibit the use of deicers containing nitrogen (Copely, 2011).

In 2011, the Chesapeake Bay Program, a watershed partnership, produced Milestone Fact Sheets that reported on the progress all the jurisdictions had made to date with their nutrient and sediment reduction goals. These fact sheets illustrated that Virginia and Pennsylvania each contain over one-third of the acreage in the Chesapeake Bay watershed and, in turn, have the largest percentage of required reductions in nutrient loading. Watershed-wide, the jurisdictions spent over $2 billion and decreased the amount of phosphorus entering the Bay by 1.05 million pounds. This is a 79% increase in their rate of progress. Examples of the kind of actions they took to gain these reductions include adding 300,000 acres to conservation tillage, 53,000 acres of forest and grass buffers, 3,800 acres of wetland restoration, over 1,000 animal waste management systems, 232,000 linear feet of non-urban stream restoration, and building almost 200 livestock and poultry waste structures. They also reduced nitrogen and phosphorus in WWTP outfalls and produced 148,000 acres of urban stormwater management, 62,000 acres of erosion and sediment control, 30 acres of tree plantings, and improved over 27,000 septic systems (Brinsfield, 2011).

3.2.2 Ohio River Basin Interstate Water Quality Trading Project

This market-based program will allow permitted emitters of nitrogen and phosphorus to purchase/trade nutrient reductions from another source within or between states in the Ohio River Basin to achieve water quality goals. The pilot phase of this trading project will run from 2012 to 2015 and will test different trading mechanisms as well as establish a framework for interstate trading. The results of the pilot will be used to direct the future framework of the project. Success will be measured by several benchmarks, including identifying and overcoming barriers to a successful full-scale roll-out, implementing trading mechanisms that are ecologically effective and acceptable to stakeholders, promoting early and voluntary participation, measuring the extent to which ecosystems can be supported, and establishing a system and protocol needed for a complete program. Once the program is fully implemented, measures of success will also include the number of nitrogen and phosphorus credits generated and traded and the net loading of nutrients prevented from reaching the water body as well as the final economic benefit to the buyers and sellers. The ultimate goal is to develop a trading market that is self-sustaining and does not require government subsidies.

Other important parts of the pilot are:

- No trade will occur that would cause an exceedance of an applicable water quality standard.
- A credit generated in one state may be applied to a NPDES permit in another state
- One credit is equal to one pound of total nitrogen (TN) or TP that is prevented from discharging into the Ohio River Basin in a given year.
- Agricultural nonpoint credits equal the load reduction achieved at the edge of the farm field.
- Point source credits equal the load reductions measured at the end of the pipe.

The primary focus during the pilot will be on nonpoint sources credits. An agricultural BMP will generate a credit after it is installed and only for as long as it is operated and maintained.

The scientific basis for water quality trading is provided by watershed models, which incorporate physical, chemical, and biological characteristics of the watershed and then incorporates point and nonpoint source loads of nitrogen and phosphorus in the watershed. This project will use two watershed models for estimating nutrient reductions from the point of generation or credit seller to the point of use or credit buyer: the U.S. EPA Region 5 spreadsheet model for estimating reductions at the edge of the field (or point of generation credit) and the Watershed Analysis Risk Management Framework model for point of use credits. The pilot will also test a USDA NRCS nutrient tracking tool. There is also interest from many of the stakeholders to consider opportunities for trading carbon credits in addition to the nutrient pollution credits (Electric Power Research Institute [EPRI], 2012).

This trading program is being designed and implemented by a group of strategic collaborators, who have also contributed funding to the project, including EPRI, Ohio River Valley Water Sanitation Committee (ORSANCO), Kieser & Associates, Ohio Farm Bureau, American Farmland Trust, Hunton & Williams, Miami Conservancy District, U.S. EPA, USDA, Duke Energy, American Electric Power, and Hoosier Rural Electric Cooperative (EPRI, 2010). ORSANCO has a working relationship with many power companies and is a collaborator with U.S. EPA and state agencies on the program. The first interstate trading plan between Ohio, Indiana and Kentucky was signed in August 2012. This will be the first time where several states will operate under the same rules and a water quality credit generated in one state can be applied in another (EPRI, 2012). EPRI received a $1.3 million grant from the U.S. EPA and USDA NRCS as well as $700,000 in matching funds from project collaborators in October of 2009 for the development of the pilot trading program.

In Ohio, the voluntary water quality trading program is in the process of being adopted and will be administered by the Ohio EPA Division of Surface Water. It allows NPDES permit holders to meet their regulatory obligations by using (trading) pollutant reductions generated by another point or nonpoint source. Public comment on the final rule language ended August 21, 2012, with revised rules being submitted to the Joint Committee on Agency Rule Review.

3.2.3 Lake Okeechobee/Everglades, Florida

Lake Okeechobee is a large, shallow, eutrophic lake that controls the hydrology of southern Florida and the Everglades. It supplies water for towns and agriculture as well as serves as flood control for the region. Recreation and commercial fishing are part of the multi-million dollar industry of the Lake Okeechobee region. Like other lake and coastal estuary systems, Lake Okeechobee has been impacted by excessive phosphorus inputs, unnaturally low and high water levels, and the spread of non-native and nuisance plants. The South Florida Water Management District (SFWMD), in cooperation with other state and Federal agencies, are responsible for addressing all these issues while maintaining water supply and flood control.

The Lake Okeechobee TMDL was established in 2001. The Florida State Legislature passed the Lake Okeechobee Protection Act (LOPA) in 2000, which mandated that the TMDL must be met by 2015. Existing phosphorus loads from agriculture and urban activities were more than five times higher than the TMDL of 140 metric tons (154 tons) per year necessary to meet the target of 40 ppm of TP. This was in spite of a decade-long effort of regulatory and voluntary incentive-based programs aimed at reducing TP input. Reevaluation of the LOPA produced a Lake Okeechobee Phosphorus Program that, fueled by strong funding support from the legislature, provided the means to implement a large number of phosphorus reduction projects for agriculture, dairy best available technologies, soil amendment projects, wetland restoration, and regional public-private partnerships. A comprehensive water quality monitoring program was also implemented, as well as ongoing research and modeling applications to provide information/data needed to predict the effectiveness of these programs on phosphorus load reductions (Zhang et al., 2007).

As part of the Lake's recovery plan, the SFWMD proposed the Lake Okeechobee Fast Track program, which would establish a series of stormwater treatment areas (STAs) to capture and treat stormwater runoff. These facilities would be located north of the lake, considered an optimal location for treating large amounts of phosphorus within state-owned properties. A software modeling system known as Systems Thinking Experimental Learning Laboratory was used to evaluate the types and locations of the STAs that would provide the best TP removal efficiencies. Based on these models, the SFWMD was able to recommend a system designed to best meet the mandated TMDLs (Rivera et al., 2009).

The SFWMD used a model to determine the phosphorus load that the agricultural region must achieve. By 2012, the SFWMD reported that they are exceeding their phosphorus reduction goals in the farming region south of Lake Okeechobee. This was accomplished through BMPs such as precise fertilizer application methods, storm water pumping practices, and erosion control methods. By the end of April 2012, more than 4,000 metric tons (4,409 tons) of phosphorus was prevented from entering the Everglades. The SFWMD expects even greater success because several more STAs will be enlarged and added, new treatment wetlands will be created along with the continuation of their research programs (SFWMD, 2012).

3.2.4 State of Wisconsin

The State of Wisconsin has a long history in fostering efforts to reduce phosphorus pollution, starting in 1933 with a watershed project to curb soil erosion. In 2010, Wisconsin banned phosphorus from lawn fertilizer and dishwashing detergent, tightened the limits on total phosphorus allowed in water bodies, set pollution “budgets” in several impaired waters, and established more stringent limits on levels of nutrients WWTPs were allowed to discharge. The changes documented in the Wisconsin Administrative Code set the highest levels of phosphorus that would be allowed in inland lakes and rivers and in the Great Lakes (Wisconsin DNR, 2010). Wisconsin was the first state in the country to adopt phosphorus water quality standards for lakes, reservoirs, rivers, and streams. In 2012, U.S. EPA approved their rule as a revision to the state’s NPDES program under the Clean Water Act. This program is also unique in that it allows permit holders to meet phosphorus discharge requirements through partnership arrangements with others entities who release phosphorus (Wisconsin DNR, 2012).

WDNR is currently reviewing an adaptive management program compared to a traditional Water Quality Trading program. There are many similarities between the two, including the fact that the WDNR has emphatically stated they will not serve as a broker or administrator for either type of plan. Both are also voluntary plans and require reductions in point and nonpoint source phosphorus inputs.

3.2.5 Central Puget Sound, Washington

Like other watersheds across the country, the Central Puget Sound Watershed in the State of Washington has been experiencing the impact of excessive nutrient loading since at least the 1960s. Also like other watersheds, they started tackling the problem through programs aimed at point source reductions. In the mid-1960s, Metro Sewage Agency was established and they built what was at the time considered the most costly pollution control effort in the country. Discharge of untreated effluent into Lake Washington was reduced to zero and a rapid improvement in water quality, including reduction in harmful algal blooms occurred (King County, 2011). This improved water quality lasted until the 1990s when once again the area lakes and Puget Sound began to experience excessive algal blooms and noxious weeds caused by too much nitrogen and phosphorus in the waterways.

The Puget Sound Action Team was created in 1996 to lead the state’s conservation efforts in response to this problem. This time they concentrated efforts on nonpoint source inputs and created the 2007-2009 Puget Sound Conservation and Recovery Plan. In July of 2007, the State passed legislation to form the Puget Sound Partnership, which took over the role of the

Puget Sound Action Team. They used the 2007-09 document to continue to guide their work and as the foundation for a new 2020 Action Agenda. The 2020 Action Agenda became the state's new comprehensive plan and is a strategy for cleaning up, restoring, and protecting Puget Sound by 2020. The seriousness of the problem and the State's commitment to it is reflected in a $460 million budget, an increase of $124 million over what was given to the original Action Team in 2005. Puget Sound is still in trouble in several areas, including a decline in salmon, orcas and marine bird populations, closures of shellfish beds, and a dead zone in Hood Canal (State of Washington, 2007). The 2020 Action Agenda sets out five major priorities that must be met by the 2020 deadline. These include: protect intact ecosystem processes, structures and functions; restore ecosystem processes, structures and functions; reduce the sources of water pollution; work effectively and efficiently together on priority actions; and build an implementation, monitoring, and accountability management system (Puget Sound Partnership, 2009).

In addition to the 2020 Action Plan for Puget Sound, the state also banned dishwashing detergents that contain more than 0.5% phosphorus by weight in 2010. Phosphates in laundry detergents had already been banned in 1994. A report discussing water quality trading in Washington and Puget Sound as a way to assist watersheds in meeting TMDLs for nutrients and other pollutants suggests that a trading program can improve cost-effectiveness, can target improvements, speed results and leverage state funds (Nelligan-Doran, 2011). The Clean Fertilizers, Healthier Lakes and Rivers law was passed on April 14, 2012, which essentially bans phosphorus in lawn fertilizers unless users can prove that the lawn absolutely needs it (Environmental Priorities Coalition, 2012). Individual lakes such as King County's Cottage Lake, have also established Lake Management Plans in response to algal blooms. Residents around the lake have been active partners in working on the lake issues and have led local efforts to provide education and outreach to residents in the watershed through a website. They have initiated BMPs regarding septic system maintenance, proper disposal of household materials, properly washing vehicles and monitoring phosphorus loading in the lake.

3.2.6 Lake Champlain, United States

There is a long history of advocacy for Lake Champlain regarding issues that affect its watersheds in New York, Vermont and Quebec. The Lake Champlain Committee (LCC), made up of members from New York and Vermont, has been involved with science-based advocacy, education and collaborative action since the mid-1960s. One of the many LCC programs is citizen monitoring, which helped guide public policy decisions, lobbied for sewage treatment upgrades, secured passage of a ban on phosphorus in laundry detergents (considered to result in the most significant reduction in pollution loading to the lake), supported BMPs for farming, and helped pass restrictions on phosphorus in lawn fertilizer, which went into effect in 2012. The phosphorus ban resulted in a fun campaign called "Don't P on your Lawn," where the LCC encouraged homeowners to use phosphorus-free fertilizers on their lawns through their website and brochures (Lake Champlain Committee, 2012).

The Lake Champlain Basin Program (LCBP), organized since 1990, works in partnership with governments in both states as well as Quebec, and with private organizations, individuals and local communities to coordinate efforts that benefit water quality in the Lake. Through the Lake Champlain Special Designation Act of 1990, a restoration plan called "Opportunities for Action" was developed and is now in the implementation phase. This act is periodically reauthorized with the latest version in November of 2010. The new Opportunities for Action Plan now contains eight goals for reducing phosphorus, preventing toxic contamination, managing aquatic invasive species, and implementing education programs to increase stewardship of the lake. Over $3.8 million in grants supporting over 700 projects have been awarded to the LCBP from 1992-2009 (Lake Champlain Basin Program, 2012).

Despite the funding and projects, Lake Champlain is still in trouble, especially with regard to nutrient inputs. In 2002, Vermont and New York developed a TMDL that was approved by U.S. EPA and included an implementation plan for reducing phosphorus. In January of 2011, the U.S. EPA disapproved the Vermont portion of the TMDL in response to a lawsuit filed by the Conservation Law Foundation that argued that the plan was not meeting federal requirements. The U.S. EPA is now working closely with the state to prepare a new TMDL. Water quality data suggests that "significant" work is required to reduce phosphorus inputs to levels that will protect the lake (U.S. EPA, 2011; Vermont Agency of Natural Resources and New York State Department of Environmental Conservation, 2002). The new TMDL is expected to be released in 2013, but this is not quick enough for many people affected by the water quality of the lake. The blue-green algae blooms are expected to continue to threaten fishing, beaches and drinking water supplies. A high-resolution topographical data study completed by the IJC identified individual fields in the land around the Mississquoi Bay (the lake basin known to contribute the largest concentration of phosphorus to the lake) that are the highest phosphorus contributors. The study predicts that 60% of the phosphorus is contributed by 10% of the land area and that corn production generates the highest level of phosphorus.

3.2.7 Saginaw Bay, Michigan

Saginaw Bay is one of three U.S. EPA Great Lakes "focus" sites for nutrient and algae assessment along with the Fox River in Wisconsin and Blanchard River in Ohio. Saginaw Bay is the topographical feature that helps form the "thumb" of the Michigan coast line along Lake Huron. It consists of a shallow inner bay with a deeper outer bay and has a drainage basin seven times larger (8,108 square miles) than the area of the bay. The Saginaw River, located near the southwestern end of the bay, accounts for 70% of the total drainage of the tributaries and draws from 80% of the basin total basin area. Water quality of the inner bay is most affected by the Saginaw River and outer bay water quality is most affected by Lake Huron. In the 1970s and 1980s, it was known that the Saginaw River contributed two metric tons of total phosphorus per day to the Bay. This was considered the largest contribution of phosphorus to the Great Lakes by any river in Michigan. Because of this, a supplement to the GLWQA in 1987 led to specific phosphorus reduction targets for the Saginaw Bay. The MDEQ also began conducting seasonal monthly water quality monitoring at seven stations. Environmental Canada (EC) has conducted ship-based monitoring since the 1960s. Although there is annual variability in the results, the monitoring to date in 2004 showed a reduction in phosphorus input to the Bay since the 1970s. Much of this data has been used to develop mathematical models that can predict loading of phosphorus from different sources. Model results indicated that re-suspension could account for 36% of TP in the spring and 68% of TP in the fall. In 2004, the majority of the water quality measurements still exceeded the target concentration of 0.015 mg/l TP (MDEQ, 2006).

One response to this problem came from the Bay County Board of Commissioners, who approved an ordinance in November 2007 to ban lawn fertilizers containing phosphorus in Bay County. Other surrounding counties have plans to or have already passed similar bans (Bay County Michigan, 2012). A statewide ban was passed in 2010 and took effect January 1, 2011.

In March 2007, a statewide Phosphorus Policy Advisory Committee identified findings and recommendations to control phosphorus on a statewide basis. In March 2008, the Saginaw Bay Phosphorus Committee, a part of the Saginaw Bay Coastal Initiative (SBCI) formed to review the findings and recommendations to determine how to turn them into actions. The SBCI is a group of interested people, businesses, and local governments in various bay front communities collaborating with state and federal agencies on actions to improve Saginaw Bay. With help from the MDEQ models, the SBCI determined that three sub-basins accounted for 53% of the phosphorus input to the Bay and that agricultural land accounted for 90% of the load. In addition, they determined that high density residential lands have a higher load per acre of phosphorus even though they equal only 10% of the total input. In order to address the phosphorus problem holistically, the SBIC Phosphorus Committee formed three workgroups consisting of an Agriculture Phosphorus Pollution Prevention Workgroup, Stormwater Phosphorus Workgroup, and a Point-Source Phosphorus Workgroup. They then developed a detailed set of recommendations and actions for each Workgroup that includes specific actions to achieve the goal of decreasing phosphorus input into Saginaw Bay and Lake Huron. The SBCI felt four key concepts for reducing phosphorus stood out. These included defining the problem, educating at all levels, building partnerships, and developing economically sustainable solutions (Saginaw Bay Coastal Initiative, 2009).

In August of 2009, the USDA Cooperative Conservation Partnership provided $1.1 million in financial assistance to a partnership between the MDEQ and the Michigan Department of Agriculture, which assists in the implementation and adoption of agricultural practices by farmers to reduce sediment and nutrient loading in Saginaw Bay and Lake Huron (MDEQ, 2009).

Also in 2009, NOAA GLERL began a five-year project to study the effects of stressors (e.g. toxic contaminants, nutrients, sediment, and over fishing, exotic species, and declining water levels) on Saginaw Bay. Results from this study will be used to develop mathematical models that will help identify management options for the Bay. The models will also help scientists simulate the outcome of various management actions such as reducing phosphorus (Dyble, 2009).

SECTION 4 – PURPOSE AND NEED OF LEIA STRATEGIC PLAN

Lake Erie's massive algae bloom in 2011 posed an economic threat to lake-dependent businesses and property values. The 2011 bloom was a wakeup call for government, researchers, businesses, environmental organizations, and citizens to join forces to reduce nutrient loading in Lake Erie, thereby reducing toxic algae in the future. Multiple initiatives are underway involving decreasing phosphorus loading and HABs in Lake Erie primarily through voluntary agricultural practices. While these actions are an important part of the equation, another critical component, water quality monitoring and data compilation especially in the lake itself, has been largely unaddressed. In 2012, the State of Ohio worked with charter boat captains to complete in-lake sampling once a week during the season. Beyond this action, there is little to no ongoing lakewide monitoring. While the focus of this Strategic Plan is mainly nutrients and HABs, and to a lesser extent Asian carp, Lake Erie also faces many threats that include sediments and turbidity, bacteria, other invasive species, water supply and use, habitat loss, changing weather, and declining sport fish populations. All of these issues are connected and must be addressed through assessment and management to protect and restore the ecological, environmental and economic value of Lake Erie.

As LEIA members recognize through our work in the Lake Erie basin and through the preparation of this plan, many voids exist with current Lake Erie research, monitoring and restoration programs and policies. From 1970-1982 there was ongoing Lake Erie monitoring that was used to determine the progress of reducing phosphorus under the new nutrient reduction policy. By 1985, Lake Erie was getting healthier and the monitoring was discontinued. While Grand Lake St. Marys, Buckeye Lake, and others currently have continuous phosphorus and/or other types of monitors, the State of Ohio has not yet placed a single continuous monitor in Lake Erie. Data and assessment are desperately needed for Lake Erie to provide the foundation for the development of wise management decisions to restore and maintain a healthy lake.

LEIA's Strategic Plan is a necessary first step for the Lake Erie community to successfully work together to promote Lake Erie's assets, to develop funding for the implementation of innovative nutrient and algae solutions, and to determine technology to control Asian carp if and when they are found in Lake Erie or elsewhere in the Great Lakes. Strategic Plan action items are to be implemented by and coordinated with the Lake Erie business community, governmental agencies and other Lake Erie stakeholders. This plan takes a business/economic approach to restoring Lake Erie and is intended to bolster and supplement certain government-led initiatives. Information, plans and, where applicable, results from government agencies and universities are referenced or incorporated into this plan in addition to developing business and nonprofit sector recommended actions. Lake Erie needs these recommendations to be implemented to realize a healthy lake that supports a healthy lake-dependent economy.

This Strategic Plan is intended to develop an economically viable unified message and plan of action on behalf of the businesses and other stakeholders that rely on Lake Erie. While the plan may incorporate potential federal and state management options, the plan focuses on recommendations that are innovative and strategic, including successful approaches from other organizations. The plan seeks to reduce phosphorus and algae and improve Lake Erie's overall health. This plan establishes a framework to promote cooperation, avoid duplication of efforts, and empower organizations with similar missions, studies and projects. Lake Erie is important to us all and we must all work together to ensure its protection and restoration.

SECTION 5 – THE STRATEGIC PLAN

5.1 Goal

Provide an economically viable plan for the sustainable restoration of Lake Erie and its tributaries through the efforts of Lake Erie economically dependent businesses and stakeholders. These efforts will also help to improve and protect the natural and economic resources of the region.

5.2 Recommended Actions

To help Lake Erie's waters and fish, it is essential that stakeholders leverage and effectively use available resources. As part of this strategic planning process, the Lake Erie Improvement Association (LEIA) chose to focus its efforts on developing specific recommended actions to complete various activities that primarily address sources of nutrient loading, harmful algal blooms, microbial contamination, and sediments/turbidity. These activities include:

- economic sustainability coordination
- outreach/education/fundraising
- water quality improvements
- water quality monitoring
- research and studies
- direct implementation projects
- support for continued aggressive efforts to keep Asian Carp out of Lake Erie
- lobbying

While the above challenges are by no means the only problems affecting or threatening Lake Erie, they are issues in which LEIA is well poised to fill a very important and necessary role. Other issues such as invasive species, water supply and use, habitat loss, changing weather, and declining sport fish populations also threaten the health and use of Lake Erie. Many of these issues currently have agency and stakeholder group champions. To the extent time and resources allow, LEIA will stay informed on these and other issues and will consider addressing them as appropriate.

5.2.1 LEIA's Lake Erie Economic Sustainability Coordination Recommendations

- Provide a platform for information exchange/dissemination that will facilitate Lake Erie-related dialogue and action among businesses, basin residents, communities, elected officials, researchers, government agencies, non-governmental organizations, and other stakeholders.
  - Maintain role as the business representative of the Lake and to act as the primary business coordinator for synchronization, monitoring of Lake health and government actions.
    - Issue annual Lake Erie Report cards
  - Maintain regular meetings with public officials and state agency leaders to establish and maintain open dialogue regarding Lake Erie issues, to identify opportunities to provide assistance, and to advocate programming that supports Lake restoration.

        - Help integrate any revisions to stakeholder practices to promote reduced nutrient loading into Lake Erie or its tributaries in tandem with government actions.

- Serve as a business representative, coordinator, and facilitator for Lake Erie interests from the economic sustainability perspective for the business/industrial community, lakeshore property owners, boaters, anglers, tourism industry and interested stakeholders.
    - Establish and implement a comprehensive membership program for this target group.
        - Solicit and enlist membership, support and participation.
    - Create and manage a program to identify, request and direct funding resources to achieve the strategic objectives of this plan.
    - Convene regular meetings of the Association that are open to the public.
    - Conduct public forums.
    - Convene and participate in other events to gain input from and provide pertinent information to this audience.
    - Solicit input on issues and actions important for this audience at LEIA meetings, networking at various functions, through the web site, and through regular outreach activities.
    - Conduct member and stakeholder surveys to gain input on issues and actions important for this audience.
    - Actively advocate for programs and projects that support its mission and serve as a voice for Lake Erie.
        - Participate in Total Maximum Daily Load (TMDL) permit processes, including issuance, compliance, and renewals.
        - Review and support, to the extent consistent with the goals and objectives defined in this strategic plan, the Ohio Lake Erie Commission's planned 2014 Lake Erie Quality Index.
        - Support the continuation, improvement and expansion of the USGS SPARROW Model.
        - Review and make recommendations based on the 2012 Great Lakes Water Quality Agreement.
        - Encourage and facilitate water quality information exchange among all permitted intake and outfall water users throughout the Lake Erie basin and advocate assistance by qualified scientists to review/evaluate a comprehensive set of data.
        - Monitor commitments of elected officials and actions of government agencies to assure that obligations are fulfilled in a timely manner.

- Implement and advocate the implementation of this Strategic Plan.
    - Hire a lobbyist to advocate LEIA's recommended actions and to secure and maintain funding for Lake Erie monitoring/water quality assessment activities and improvement projects.
    - Review progress to ensure timely plan implementation.

- Implement certain actions not being completed by others via association staff, hired consultants, or team members.
- Advocate to and empower others to implement recommended actions.
- Develop a non-partisan political action strategy with clearly defined objectives that can effectively guide LEIA's interaction with elected officials and the ability to lobby for funding to help Lake Erie.

5.2.2 LEIA's Public Outreach/Educational Activities/Fundraising Recommendations

- Solicit input from the public and help the public gain an understanding about Lake Erie issues of concern and solutions by communicating with businesses, basin residents, communities, researchers, government agencies, non-governmental organizations, and other stakeholders.

    - Establish and maintain a communication plan to integrate stakeholder ideas and to provide continual flow of information that will likely include activities such as continued web site maintenance, member update notifications, newsletters, public forums, and events.
    - Help promote the public understanding of causes and solutions to Lake Erie impacts by establishing an education and outreach plan.
    - Conduct or partner with organizations to complete events such as forums, meetings, festivals, etc.
    - Establish a media plan, including social networking.
    - Establish and implement a comprehensive funding/fundraising plan to support the objectives of the strategic plan.
        - Pursue grants from government sources and foundations.
        - Develop marketing tools.
        - Develop a three-year membership plan.
        - Develop relationships with foundations and funding organizations whose goals are in alignment with LEIA objectives.

5.2.3 Water Quality and Monitoring Recommendations

- Install and maintain real time continuous monitors that will provide data and create an ongoing Lake Erie and tributary outfall management assessment.

- Work with governmental agencies to determine targeted phosphorus and nitrogen loads at tributary outfalls and within Lake Erie.

- Support funding for research on causes and potential solutions to HABs, including maintenance of the Heidelberg tributary monitoring program and the Lake Erie Millennium program and Lake Erie-wide cooperative research that includes all Lake Erie watershed states and the province of Ontario.

- Continue and expand Charter Boat sampling activities and pursue and implement similar opportunities.

- Promote federal, state, and local participation and funding commitments for healthy Lake Erie programs and policies.

  - Continue and expand programs that address Lake Erie health concerns such as the Great Lakes Restoration Initiative.

- Work with the International Joint Commission (IJC) on recommendations for phosphorus and nitrogen levels that are targeted to realize a healthy Lake Erie.

- Support NOAA's HAB tracking program and establish a predictive model on cyanobacteria.

- Advocate for a Great Lakes algae/nutrient task force similar to the Asian carp program to assess algae/nutrient stressed Great Lakes waters. The task force would make recommendations on nutrients/algae for the stressed Great Lakes waters and a management plan for Great Lakes waters that may be nutrient/algae-stressed in the future. The Task Force would also review what has worked and not worked in other areas, targeting nutrient/algae.

- Encourage improved use and resources for Lakewide Management Plan (LaMPs).

- Establish a lakewide TMDL and TMDLs for all Lake Erie tributaries

- Complete 303d (impaired waters) list and evaluate for Lake Erie and the Lake Erie watershed.

- Support funding for a Lake Erie economic impact study that incorporates the IJC's Lake Erie economic impact study.

- Secure funding for Battelle to solicit and review business proposals and recommend projects for in-lake and tributary pilot, short-term, and long-term projects that can give relief to waters with excess nutrients or to address other lake challenges. Secure funding to implement those projects.

5.2.4 Source-Specific Water Quality Issues Recommendations

Agriculture

- Reduce phosphorus runoff from agricultural land by one pound or more per acre with a combination of reduced inputs and implementation of BMPs.

- Continue and expand 4Rs Program (right fertilizer, right rate, right time, and right place) that includes requirement for GIS-based grid soil tests on all acres in the Lake Erie basin.

- Encourage the implementation of the Tri-State (Ohio State, Michigan State, Purdue University) fertility standards.

- Encourage Certified Crop Advisors, soil test laboratories, and fertilizer retailers to follow Tri-State fertility standards.

- Implement Soil Test Phosphorus (STP) maximum level of 40 ppm.

- Encourage farmers to integrate annual in-row fertilizer applications and incorporate broadcast applications in a timely manner.

- Encourage the implementation of best management practices (BMPs) that include filter strips, cover crops, conservation tillage, and controlled drainage.

- Tie conservation compliance to crop/revenue insurance and Farm Bill-funded subsidies.

- Re-evaluate National Crop Insurance program to eliminate transfer of crop yield history to newly purchased or rented land. Use only the actual field yield history or if no record exists, use the county average. This will help reduce the incentive to farm marginal, highly erodible acreage.

- Implement plan to educate Certified Crop Advisors and agriculture retailers about the benefits of proper application and the negative consequences (both economically and environmentally) of over-application of nutrients.

<u>Animal Manure</u>

- Require certified audits of at least 10% of the animal feeding operations.

- Require full accountability of animal feeding operations that links third party records from the certified livestock managers with records from the production facility.

- Establish new permit for smaller confined animal facilities at 50% of the existing animal unit threshold (create a streamlined permit that is not as expensive or cumbersome to complete but includes a nutrient management plan).

- Lower the maximum STP standard to 40 ppm in the livestock permitting rules.

- Phase out the use of the Phosphorus Risk Index and use only the 40 ppm STP standard.

- Encourage the use of new technologies for manure processing to allow for economical exportation.

- Encourage implementation of BMPs that include composting, incorporation and variable rate application.

- Implement plan to educate livestock producers about the benefits of appropriate nutrient management and the negative consequences (both economically and environmentally) of over-application of nutrients.

Water and Wastewater

- Inventory all public and private water systems within the Lake Erie watershed. Identify locations of water intakes, threats, and costs associated with water quality and quantity for both public and private intakes.

- Inventory all public and private wastewater systems within the Lake Erie watershed. Identify the largest sources of nutrient discharge and other pollutants.

- Determine appropriate phosphorus and nitrogen limits for water and wastewater plants in the Lake Erie basin based on Best Available Technology. Phosphorus limits have been required at some wastewater treatment plants in the U.S. and in some instances have been set at 0.1 ppm or less.

- Advocate for all political jurisdictions in the Lake Erie watershed, including the province of Ontario, to disclose the locations and amounts of combined sewer overflows (CSO) and sanitary sewer overflows (SSO) discharges to Lake Erie.

- Establish standard language for the National Pollution Discharge Elimination System (NPDES) permit review processes and distribute to plants and regulatory agencies to advocate consistent standards and processes at plants throughout the basin.

- Support cooperation between the states of Ohio and Michigan to find innovative ways for the Detroit Wastewater Treatment Plant (WWTP) to improve its compliance with regard to phosphorus loadings to the Detroit River and CSO discharges.

- Continue to actively participate in the consortium to improve Detroit WWTP operations, including CSO and SSO issues, and to actively review and comment on the permit renewal.

- Seek innovative in-water and end-of-pipe processes, treatment technologies (including P and N reductions), and alternative practices/reductions in water use (including thermal) which will improve the health of Lake Erie.

- Assess the potential use of a water quality trading program within the Lake Erie watersheds that would allow NPDES permit holders to meet phosphorus discharge requirements through partnership arrangements with others entities who release phosphorus.

- Better understand the impacts and potential impacts of deteriorating sewage pipes/conveyance systems leaching into stormwater systems and waterways.

Septic

- Understand septic system patterns in the Lake Erie watershed, including current performance, local regulations and enforcement.

- Encourage the enforcement of existing septic system regulations.

- Support, advocate or comment on regulations, management programs or funding programs that reduce water quality impacts and assist with incorporation of BMPs for septic tank installation and maintenance/operations.

- Advocate for the development and use of methodologies to best evaluate the performance of already-installed septic systems to determine their impacts to nutrient loads.

- Advocate for financial incentives to assist homeowners with installation, operation and maintenance of appropriate systems.

<u>Stormwater/Combined Sewer Overflows/Sanitary Sewer Overflows</u>

- Research proposed and implemented remedies and the status of remedies for CSOs and SSOs at all public/private water and WWTPs in the Lake Erie watershed.

- Advocate for the ban of the use of phosphorus in fertilizers for residential yards/existing lawns within the Lake Erie watershed.

- Advocate for the ban of the use of phosphates in dishwashing detergents sold within the Lake Erie watershed.

- Advocate for green infrastructure solutions as long-term remedies for storm capacity limitations for public and private WWTPs.

- Establish a series of stormwater treatment areas that capture and treat stormwater runoff.

- Require holding structures for first flush for stormwater.

<u>Open Lake Dumping</u>

- Support Ohio EPA in its efforts to eliminate open lake placement of Toledo shipping channel dredged sediments in Maumee Bay. Support funding and implementing alternatives to open lake dumping, as proposed in the Toledo Harbor Sediment Management and Use Plan. This plan includes several short- and long-term alternatives, including beneficial use and environmentally acceptable dredging techniques.

- Support conducting a pilot project as an interim measure for open lake placement in Maumee Bay to amend sediments prior to placement to help bind phosphorus and help settle materials and keep them in place so they do not re-suspend.

- Support conducting pilot projects to demonstrate the feasibility and implementability of beneficial use of dredged sediments.

- Support increased funding for USACE for Toledo Harbor and Cleveland Harbor shipping channel sediment management with assistance to be comparable to other areas of the country.

Select Issues of Concern

- Support efforts to prevent introduction of Asian carp into the Great Lakes and Lake Erie basin.

- Prepare an emergency response plan now to be prepared for the time if and when Asian carp are found in Lake Erie.

- Support efforts and policies to maintain water levels and quantity in Lake Erie.

- Support efforts to reduce nutrient and pollutant flow from the land to improve Lake Erie and tributary water quality.

6.0 INITIAL LOBBYIST PRIORITIES

After significant scrutiny during this strategic planning process, LEIA came to the conclusion that hiring a lobbyist is the best path forward for an economically sustainable Lake Erie. This lobbyist will advocate LEIA's recommended actions and seek funding for the following priority actions. Though this is the initial set of priorities, the lobbyist will also address recommendations listed in Section 5 as time allows and as funding and opportunities arise.

- Continue, expand and leverage programs that address Lake Erie water quality concerns, including source reduction of excess nutrients causing toxic algal blooms. Programs include:
  - Healthy Lake Erie Fund;
  - Great Lakes Restoration Initiative for a variety of improvement projects;
  - State Revolving Funds;
  - Other programs to assist with water quality and wastewater infrastructure improvements.

- Review all major point source permits, such as the Detroit WWTP, and determine phosphorus and nitrogen limits for plants in the Lake Erie basin based on Best Available Technology.

- Secure and maintain federal, state, local, private, and other sources of funding for long-term continuous lakewide and tributary outfall nutrient monitors.
  - Install and maintain continuous water quality monitoring systems near 12 publicly operated water intakes and wastewater treatment plants (upstream of their discharge).

- Establish a Lakewide Total Maximum Daily Load and Total Maximum Daily Loads for all Lake Erie tributaries.

- Work with the International Joint Commission to create benchmarks and funding recommendations for phosphorus and nitrogen levels that are targeted to realize a healthy Lake Erie.

- Encourage state agencies to complete 303d (impaired waters) list and evaluate information and recommend actions specifically for Lake Erie and the Lake Erie watershed.

- Prepare a Lake Erie economic impact study that incorporates findings of the IJC's Lake Erie economic impact study. It is expected that the Lake Erie economic impact study will include shipping, industry, energy, agriculture, commercial and sport fishing, and tourism-related economic factors.

- Secure an estimated $250,000 in funding for Battelle to solicit and review business proposals and recommend selected proposals for in-lake and tributary pilot, short-term, and long-term projects that can give relief to waters with excess nutrients or to address other lake challenges. Secure and maintain funding for implementation of selected projects.

- Support the agriculture community to reduce phosphorus runoff from agricultural land by one pound or more per acre with a combination of reduced inputs and implementation of best management practices.

- Support a ban on the placement of fertilizer, including manure, on frozen ground.

- Support a ban on open lake dumping of sediments from the Toledo shipping channel along with supporting funding activities for habitat restoration units and other beneficial use alternatives to open lake dumping of the Toledo shipping channel sediments.

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ACRONYM LIST

AOCs	Areas of Concern
BMPs	Best Management Practices
BUI	Beneficial Use Impairment
CDF	Confined Disposal Facility
CAFO	Confined Animal Feeding Operation
CND	Canadian Dollars
CSO	Combined Sewer Overflow
DNMC	Delaware Nutrient Management Commission
DRP	Dissolved Reactive Phosphorus
EC	Environment Canada
EPRI	Electric Power Research Institute
GLAB	U.S. EPA Great Lakes Advisory Board
GLERL	Great Lakes Environmental Research Lab
GLRI	Great Lakes Restoration Initiative
GLWQA	Great Lakes Water Quality Agreement
HABs	Harmful Algal Blooms
IJC	International Joint Commission
LaMP	Lakewide Management Plan
LEEP	Lake Erie Ecosystem Priority Project
LEIA	Lake Erie Improvement Association
LEPR	Lake Erie Protection and Restoration Plan
LOPA	Lake Okeechobee Protection Act
MDEQ	Michigan Department of Environmental Quality
NCWQR	National Center for Water Quality Research
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
ODNR	Ohio Department of Natural Resources
OEC	Ohio Environmental Council
Ohio EPA	Ohio Environmental Protection Agency
ORSANCO	Ohio River Valley Sanitary Commission
OSU	Ohio State University
P	Phosphorus
Ppb	Parts Per Billion
RAP	Remedial Action Plan
SBCI	Saginaw Bay Coastal Initiative
SFWMD	South Florida Water Management District
SPARROW	SPAtially Referenced Regressions On Watershed attributes
SSO	Sanitary Sewer Overflow

STAs	Stormwater Treatment Areas
STP	Soil Test Phosphorus
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WARMF	Watershed Analysis Risk Management Framework
WHO	World Health Organization
WIP	Watershed Improvement Plan
WLEB	Western Lake Erie Basin Partnership
WWTP	Wastewater Treatment Plant

APPENDIX A: FURTHER DISCUSSION ON PHOSPHORUS MONITORING

As discussed in the Strategic Plan, nutrient loading to Lake Erie is highly dynamic, with the various Lake Erie tributaries and input types (e.g. nonpoint, point) contributing to the annual phosphorus load. The lack of continuous monitoring in Lake Erie makes it hard to determine the exact contribution of these factors to phosphorus loads. Two methods of estimating phosphorus loading to Lake Erie are tributary monitoring and predictive models. The National Center for Water Quality Research at Heidelberg University operates the Tributary Monitoring Program, which collects comprehensive water quality monitoring in Ohio's major tributaries. Their loading numbers are combined with point source reporting data, other tributary monitoring data, and additional data to obtain estimates of the annual loads to Lake Erie. The Tributary Monitoring Program has provided water quality data for the last 30 years and is one of the most detailed and longest running water quality monitoring programs in the U.S.

Predictive models developed for Lake Erie tributaries are also used to calculate the amount of phosphorus entering Lake Erie. The U.S. Geological Survey (USGS) recently completed a model to assess nutrient conditions and estimate loads and sources of phosphorus to the U.S. portions of the Great Lakes. The SPARROW model (SPAtially Referenced Regressions On Watershed attributes) empirically estimates the origin and fate of contaminants in streams and receiving water bodies. This model is GIS-based and incorporates a mass-balance approach to estimate nutrient sources, transport and losses (Robertson and Saad, 2011). Data used to develop this model was normalized to 2002 conditions. Normalizing the data results in a more robust mass-balance compared to reliance on single-year hydrologic records.

There is some discussion in the scientific community about which method is more appropriate to use to estimate total phosphorus loading in Lake Erie. These two methods suggest some differences in the types and amounts of total phosphorus loading. The SPARROW model estimates that the total U.S. load to Lake Erie, excluding contributions from Lake Huron and atmospheric sources, is approximately 4,610 metric tons; the International Joint Commission (IJC) method, which includes Lake Huron and atmospheric contributions, estimates a total load of 9,733 metric tons (Richards et al., 2011). Even without Canadian and atmospheric contributions, the IJC estimate is 6,730 metric tons, or 146% of the load estimated by SPARROW (Richards et al., 2011).

In addition to the discrepancies in total load, there are also discrepancies in percentage of contributions from various sources. As Figure A-1 shows, inputs of phosphorus to Lake Erie and the western basin are highly variable. Graph A in Figure A-1 depicts relative phosphorus loading contributions in the western Lake Erie basin in 2005. Tributary data was provided by Heidelberg University for the Maumee, Sandusky, and Raisin rivers and the Detroit River data was provided by Joe DePinto of LimnoTech, with data compiled by the Lake Erie Waterkeeper. Phosphorus loads are determined by combining tributary nonpoint data (with adjustments for non-monitored areas), point source loads, and estimated atmospheric deposition onto Lake Erie and inputs from Lake Huron (Richards et al., 2011).

Graph B in Figure A-1 depicts phosphorus loading in the western Lake Erie basin as predicted by the USGS SPARROW model. This model estimates long-term average phosphorus loads normalized to 2002 conditions, but does not include nutrient loads from the Canadian side. Graphs A and B show that the Detroit River and Maumee River are the main contributors of phosphorus to the western basin. The Detroit Wastewater Treatment Plant is the main source of phosphorus for the Detroit River, while agricultural runoff is the main phosphorus input for the Maumee River.

Graphs C and D in Figure A-1 depict phosphorus loading in Lake Erie as a result of point, nonpoint and atmospheric sources. Graphs C and D show large differences in the data. The Graph C data prepared by Ohio EPA and cited in the Ohio Phosphorus Phase I Task Force states that nonpoint sources contribute 61% of total phosphorus, while the SPARROW data in Graph D suggests that nonpoint sources contribute 51%. Further, there is a large difference in the suggested contribution of point sources to Lake Erie phosphorus loads, with graph C indicating 20% of total phosphorus through point sources while SPARROW suggests over twice that. There is also some discrepancy between the two methods on the contribution from agricultural loads, with SPARROW indicating 58% from fertilizers and 42% from manure, while field-scale tests indicate fertilizers account for 71%-74% of applied nutrients and manure only 26%-29% (Richards et al., 2011). The results and implications of the SPARROW model, and the exact contributions of point and nonpoint sources, remain topics of debate among researchers, agency officials, and Lake Erie stakeholders.

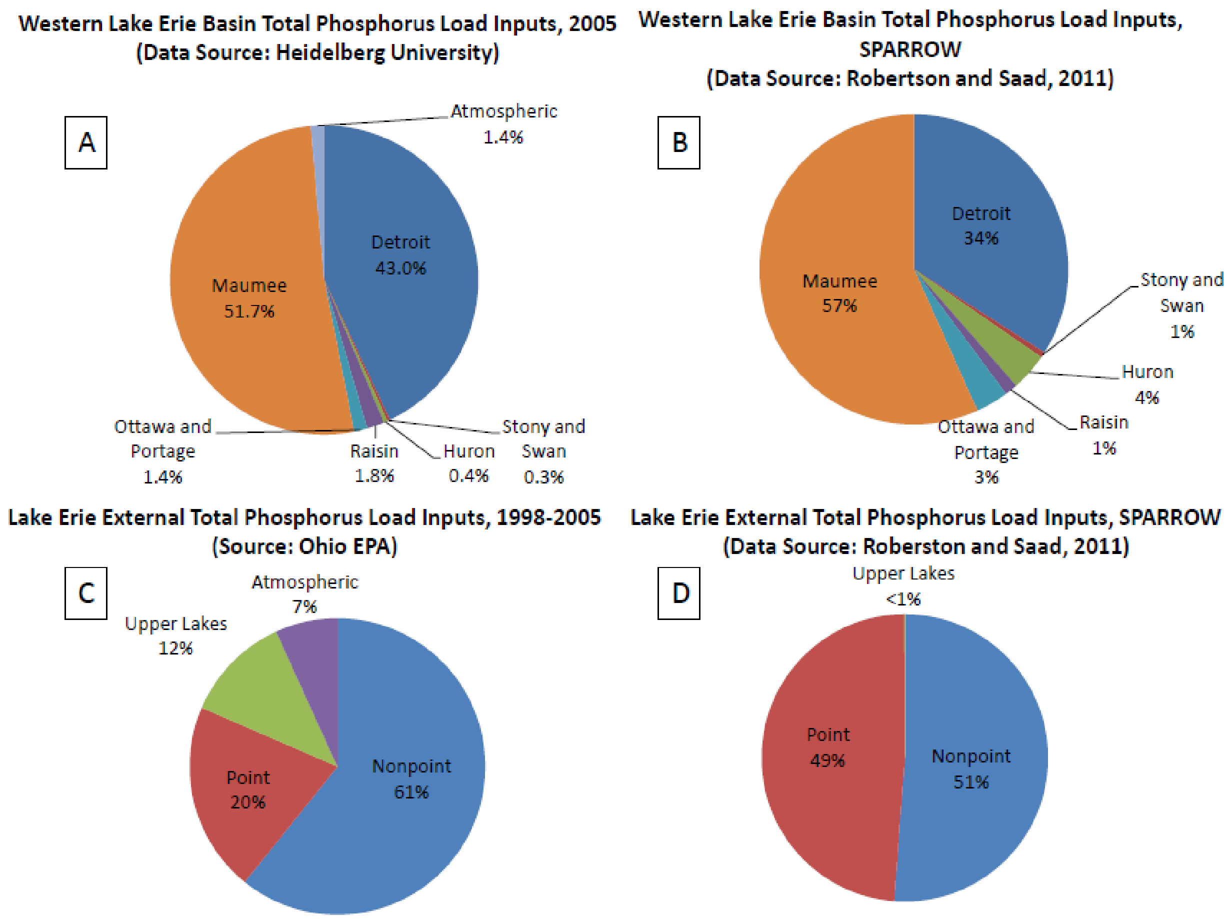

Figure A-1. Graph A: 2005 Western Lake Erie basin total phosphorus load inputs by tributary (Source: Lake Erie Waterkeeper). Graph B: 2002 Western Lake Erie basin total phosphorus load inputs based on USGS SPARROW Model (Data compiled by Lake Erie Waterkeeper, Source: Robertson and Saad, 2011). Graph C: Lake Erie external total phosphorus inputs to Lake Erie from 1998-2005 (Source: Ohio EPA, 2010). Graph D: 2002 Lake Erie external total phosphorus inputs to Lake Erie based on USGS SPARROW model (Source: Data compiled by Lake Erie Waterkeeper, Source: Robertson and Saad, 2011).

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